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**DEVELOPMENT OF A SYSTEMWIDE PREDATOR
CONTROL PROGRAM:
STEPWISE IMPLEMENTATION OF A PREDATION INDEX,
PREDATOR CONTROL FISHERIES, AND EVALUATION
PLAN IN THE COLUMBIA RIVER BASIN**

SECTION I: IMPLEMENTATION

1994 ANNUAL REPORT

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In Cooperation With

Washington Department of Wildlife
Pacific States Marine Fisheries Commission
Columbia River inter-Tribal Fish Commission
Confederated Tribes of the **Umatilla** Indian Reservation
Confederated Tribes of the Warm Springs Reservation
Nez Perce Tribe
Yakama Indian Tribe
Oregon Department of Fish and **Wildlife**

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EXECUTIVE SUMMARY

by Charles F. Willis

We report our results **from** the forth year of a basinwide program to harvest northern squawfish (*Ptychocheilus oregonensis*) *in an effort* to reduce mortality due to northern squawfish predation on juvenile **salmonids** during their emigration from natal streams to the ocean. Earlier work in the **Columbia** River Basin suggested predation by northern **squawfish** on juvenile **salmonids** may account for most of the 10-20% mortality juvenile **salmonids** experience in each of eight Columbia and Snake River reservoirs. Modeling simulations based on work in John Day Reservoir from 1982 through 1988 indicated it is not **necessary** to eradicate northern squawfish to substantially reduce predation-caused mortality of juveniles **salmonids**. Instead, **if northern squawfish** were exploited at a 10-20% rate, reductions in numbers of larger, older fish resulting in restructuring of their population could reduce their predation on juvenile **salmonids** by 50% or more.

Consequently, we designed and tested a sport-reward angling fishery and a commercial **longline** fishery in the John Day pool in 1990. We also conducted an **angling** fishery in areas inaccessible to the public at four dams on the **mainstem** Columbia River and at Ice Harbor Dam on the Snake River. Based on the success of these limited efforts, we implemented three test fisheries on a multi-pool, or systemwide, scale in 1991 -- a tribal **longline fishery** above Bonneville Dam, a sport-reward fishery, and a dam-angling fishery. Low catch of target fish and high cost of implementation resulted in discontinuation of the tribal **longline** fishery. However, the **sport-reward** and dam-angling fisheries were continued in 1992 and 1993. In 1992, we investigated the feasibility of implementing a commercial **longline** fishery in the Columbia River below Bonneville Dam and found that implementation of this fishery was also infeasible.

Although we were unable to implement an effective **longline** fishery, it was important to attainment of program objectives to attempt to substantially increase total annual exploitation. Estimates of combined annual exploitation rates resulting from the sport-reward and dam-angling fisheries remained at the low end of our target range of 10-20%. This suggested the need for additional, effective harvest techniques. During 1991 and 1992, we developed and tested a modified (small-sized) **Merwin** trap net. We found this floating trap net to be very effective at catching northern squawfish at specific sites. Consequently, in 1993 we examined a systemwide fishery using floating trap nets, but found this **fishery** to be ineffective at harvesting large numbers of northern **squawfish** on a systemwide scale.

In 1994, we investigated the use of trap nets and gill nets at site-specific locations where concentrations of northern squawfish were known or **suspected** to occur during the spring season (i.e., March through early June). In addition, we initiated a concerted effort to increase public participation in the sport-reward fishery through a series of promotional and incentive activities. Results of these efforts are subjects of this annual report under Section I, Implementation. In this **section**, we also report on the system we used to **collect** and dispose of harvested northern

squawfish. An evaluation of the cost **effectiveness** of a food-grade fish handling network is included.

Evaluation of the success of test fisheries in achieving our target goal of a 10-20% annual exploitation rate on northern squawfish is presented in Section II of this report. Overall program success in terms of altering the size and age composition of the northern squawfish population and in terms of potential reductions in loss of juvenile **salmonids** to northern **squawfish** predation is also discussed under Section II.

The fishery implementation and evaluation team includes the Columbia Basin Fish and Wildlife Authority (Authority), Pacific States Marine Fisheries Commission (**PSMFC**), **S.P. Cramer and Associates, Inc. (SPCA)**, Oregon Department of Fish and **Wildlife (ODFW)**, Washington Department of Fish and Wildlife (**WDFW**), Columbia River Inter-Tribal Fish Commission (**CRITFC**), and the four lower Columbia River treaty tribes - the Confederated Tribes of the **Umatilla** Indian Reservation the Confederated Tribes of the Warm Springs **Reservation**, the Nez **Perce** Tribe, and the **Yakama** Indian Nation. The Authority and **PSMFC**, with assistance from **SPCA**, were responsible for **coordination** and administration of the entire program; **PSMFC** subcontracted various tasks and activities to **ODFW**, **WDFW**, **CRITFC**, and the four lower Columbia River treaty tribes based on expertise each brought to the tasks involved in implementing the program. Objectives of each cooperator related to program implementation were as follows,

1. **WDFW** (Report A): Implement a systemwide (i.e., Columbia River below Priest Rapids Dam and Snake River below **Hells Canyon Dam**) sport-reward fishery.
2. **PSMFC** (Report B): Process and provide accounting for reward payments to participants in the sport-reward **fishery**.
3. **CRITFC** (Report **C**): Implement a systemwide angling fishery at eight **mainstem** darns on the Snake and Columbia rivers.
4. **CRITFC** (Report D). Implement a fishery for removing northern **squawfish** near hatchery release sites and at other site-specific locations where concentrations of northern **squawfish** are known or suspected to occur.
5. **SPCA** (Report E): Establish a private-sector operated system for collecting and disposing of harvested northern **squawfish**, coordinate system operations with fishery implementation activities, and evaluate the cost effectiveness of a food-grade fish handling network as a component of the overall fish handling system.
6. **ODFW** (Report F): Evaluate exploitation rate and size composition of northern squawfish harvested in the various fisheries implemented under the program together with an assessment of incidental catch of other fishes. Estimate reductions in predation on juvenile **salmonids** resulting from northern squawfish harvest. Evaluate changes in relative abundance, size and age structure, growth, and **fecundity** of northern **squawfish** and

consumption rates **of juvenile salmonids** by northern **squawfish** in lower Columbia and Snake River reservoirs and in the Columbia River below Bonneville Dam.

In addition to the activities listed above, ODFW conducted a limited lure trolling **fishery** for northern **squawfish** in the Bonneville Dam **tailrace** boat restricted zone from mid-June through mid-July 1994. A total of 75 hours of trolling produced a catch of 843 northern squawfish. No salmonids were intercepted.

Background and rationale for the Northern **Squawfish** Management Program study can be found in Report A of our 1990 annual report (Vigg et al. 1990). **Highlights** of results of our work in 1994 by report areas follows.

Report A Implementation of the Northern **Squawfish** Sport-Reward Fishery in the Columbia and Snake Rivers

1. Objectives for 1994 were to implement the sport-reward fishery for northern **squawfish** in the lower Snake and Columbia rivers, to conduct a survey to assess impacts of the fishery on non-target fish species, to initiate an incentive and promotional program to increase angler participation and **catch**, and to report on the dynamics of the fishery and **promotional** program.
2. The northern **squawfish** sport-reward fishery was conducted from May 2 through September 25, 1994. Fourteen registration stations were located throughout the lower Snake and Columbia rivers.
3. A total of 129,434 northern squawfish equal to or greater than 11 inches in total length were returned to registration stations for reward vouchers during the 1994 season. These fish were caught during 20,795 **successful** angler days, which represented 51% of the total number of angler days fished (40,783) by registered anglers. Harvest of northern **squawfish** increased by **24%** over that observed in 1993, decreased by 3% compared to that observed in 1992, and decreased by 19% compared to that observed in 1991, with a decrease in angler participation during 1994 compared to levels observed in any of the three prior years. Catch per unit effort (**CPUE**) in 1994 was 3.17 fish per angler day, and was significantly greater (**P<0.0001**) than any of the previous three years. An additional 7,707 northern **squawfish** under 11 inches total length were also returned to registration stations.
4. Lengths of northern **squawfish** over 250 mm fork length (i.e., 11 inches total length) averaged 335 mm in 1993 and in 1994, which represented a statistically significant decrease in mean fork length between 1992 (346 mm) and 1993. A statistically significant decrease in mean fork lengths was also **observed** between 1991 (350 mm) and 1992, suggesting a continuing trend in decreased average size of northern squawfish harvested in the sport-reward fishery during the initial years of the harvest program.

5. Registration station totals of harvested game fishes (22 species) other than northern **squawfish** and of **unclassified** fishes (six species) in 1994 indicated that no species was excessively harvested under the Northern Squaw-fish Management Program.
6. To obtain additional catch **information**, we conducted a phone **survey** of anglers who did not return to registration stations following their fishing trip. **Harvest** estimates for **non-returning** anglers included 1,730 northern squawfish that were 11 inches or larger and 5,840 northern **squawfish** that were less than 11 inches in total length. Catch estimates for other fish species included 1,320 **smallmouth** bass (*Micropterus dolomieu*), 500 walleye (*Stizostedion vitreum*), 80 steelhead (*Oncorhynchus mykiss*), 10 chinook salmon (*Oncorhynchus tshawytscha*), and 80 white sturgeon (*Acipenser transmontanus*).
7. Preliminary results from initiation of incentive and promotional activities were promising in terms of contributing to increased angler participation in special events and in terms of associated increase in harvest of northern squawfish.
8. An assessment of costs for implementing the sport-reward fishery in 1994 indicated a cost range from \$1.36 (at The **Fishery**) to \$24.57 (at **Umatilla**) per northern squawfish harvested at each of the 14 registration stations. The overall project cost per harvested northern squawfish was less in 1994 (\$4.68) than in 1993 (\$10.62) or 1992 (\$9.68).
9. We **recommend** that the 1995 sport-reward fishery start in early May and extend through mid-September. **Nine** full-time and 15 satellite registration stations should be operated with one **shift** per day **extending** from 1 p.m. to 9 p.m. seven days per week. Self registration during periods when stations are closed should continue. Registration stations should be operated throughout the area in which the fishery was implemented during 1991 through 1994. A phone survey should continue to provide **information** regarding total catch of target and non-target fishes, to **evaluate** satisfaction with the program, and to provide information needed to **evaluate** the effectiveness of incentive and promotional activities. An aggressive public relations program should be continued to increase awareness **of**, participation in, and efficiency of the sport-reward fishery.

Report B

Northern Squawfish Sport-Reward Fishery Payments

1. During 1994, a total of \$396,364 was paid to anglers for 127,531 northern squawfish harvested in the sport-reward fishery.
2. A total of 13,434 vouchers were processed of which 13,141 were standard vouchers representing a harvest of 127,238 fish and 293 vouchers for tagged northern **squawfish** (one tagged fish per voucher). Non-tagged fish were processed with an award payment of \$3 per fish while tagged fish were processed with an award value of \$50 per fish. Not **all** vouchers issued to anglers were submitted for reward payment.

3. The mean catch was 9.7 northern **squawfish** per voucher.
4. Voucher processing proceeded smoothly with checks being cut and mailed to the angler within five days **after** receipt of the voucher.
5. Vouchers that had missing or incomplete information were returned to anglers for completion causing delay in payment. Vouchers that were not returned, or for which missing information was not provided, were rejected for payment.
6. The number of vouchers that were rejected totaled 93 with a combined potential reward of \$726. There were a variety of reasons for vouchers being rejected, the most common being **failure** to complete the required questionnaire and submitting the voucher beyond the deadline for payment.
7. In addition to voucher processing, awards for weekly tournaments (246 prizes; \$20,500), monthly drawings (25 **prizes**; \$10,000), special tagged fish drawings (2 **prizes**; \$10,000), **G.I. Joe's** tournaments (24 prizes; \$5,000), and upper river tournaments (24 prizes; \$4,000) were processed. Voucher payments and program award payments totaled \$445,864 in 1994.

Report C

Controlled Angling for Northern Squawfish at Selected Dams on the Columbia and Snake Rivers

1. Dam angling at eight damson the lower Snake and Columbia rivers during 1994 resulted in a catch of 16,097 northern **squawfish** from May through **early** September. This was equivalent to **95%** of the 1993 catch.
2. Total effort (10,002 hours) increased **3%** compared to effort in 1993. Overall catch per angler hour (1.6) has remained relatively unchanged for the last three years (1992-1994). The **mobile** angling crew fished at Bonneville, The **Dalles**, and John Day dams, which yielded 25% of the total catch at a catch rate of 2.8 northern **squawfish** per angler hour.
3. Fishing effort at Snake River dams decreased by 43' % in comparison to 1993 effort because of continuing low catch rates of northern **squawfish**. However, Snake River catch rates did increase slightly over those observed in 1993. The catch rates of northern **squawfish** in 1994 at Columbia River dams decreased at Bonneville, John Day, and McNary dams and increased at The **Dalles** Dam compared to 1993 catch rates.
4. Incidental species caught as compared to the total catch decreased significantly from 5.5% in 1993 to 2.3°/0 in 1994. Bass comprised nearly half of the total **bycatch** with white sturgeon comprising another 20°/0 of the **bycatch**. Twelve juvenile and no adult **salmonids** were caught in 1994. Nine were released in good **condition**, two in poor **condition**, and one died.

5. We recommend that dam angling be continued at all eight lower Columbia and Snake River dams. Effort allocation adjustments should include an increase in effort at Bonneville and The **Dalles** dams using one crew whose effort is distributed between these dams based on weekly catch rates, and a decrease in effort at **McNary** Dam. Effort at John Day Dam should be maintained at the 1994 level. We also recommend continuing to use a mobile crew to fish at all four Snake River dams, focusing effort at Lower Granite Dam. The times and locations of daily effort at each dam should be distributed based on inseason monitoring of catch with a focus on dawn and dusk fishing periods. Boat crews should continue to be used in boat restricted zones (**BRZs**), particularly during high discharge periods, **to** catch northern squawfish in protected areas beyond the reach of dam-based anglers. A mobile crew should be employed below Bonneville Dam to conduct boat angling, lure trolling, and **longlining** in the BRZ. We include **longlining** on an experimental basis because its use may be **effective** when limited to **BRZs**. The volunteer angling effort should be expanded to 8-10 groups.

Report D

Site-Specific Removal of Northern Squawfish Aggregated to Feed on Juvenile Salmonids in the Spring in the Lower Columbia and Snake Rivers using Gill Nets and Trap Nets

1. Small-meshed **gill** nets and trap nets were used to catch 9,024 northern squawfish that were 250 mm fork length (**FL**) or longer during April through June 1994. Most of the catch was taken with gill nets (99.9%) and at locations in Bonneville Pool (**98.5%**). The mouth of the **Klickitat** River was the most productive fishing location. The most productive locations outside of **Bonneville** Pool were the mouths of the **Umatilla** and ClearWater rivers.
2. The total incidental catch of fishes for both gillnetting and trapping was 5,876 fish comprising approximately 20 species. Suckers (***Catostomus*** spp.) were the predominate **bycatch** in **gill** nets. **Salmonids** comprised only 1% of total gill-net catches.
3. We recommend continuation of the site-specific fishery using **gill** nets only. Suitable **site-specific** fishery locations below Bonneville Dam should be investigated. The site-specific fishing season should be extended through the end of June, and **daily** fishing should be extended to one hour past sunrise. Other operational criteria should be reviewed and modified to increase operational efficiency while protecting against excessive interception of **salmonids**.

Report E
Handling and Transportation of Northern Squawfish Harvested
under the Columbia River Northern Squawfish Management Program in 1994
and Evaluation of the Cost Effectiveness of a Food-Grade Fish Handling Network

1. Approximately 164,000 northern **squawfish** were harvested under the three fisheries implemented in 1994. We established a **private-sector** operated fish handling system to collect and transport **harvested** northern squawfish to end users, and we **successfully** coordinated activities among end users and fishery managers.
2. The 1994 fish handling system included a food-grade fish collection network located in the lower **Columbia** River. Operation of this network was less expensive than operation of a rendering-only network covering the same area would have **been**, based on handling of 111,536 pounds of northern **squawfish** harvested in the food-grade network area. Sale of food-grade fish generated \$8,677 from 78,881 pounds of useable fish. Implementation of the food-grade network cost \$38,927, which was \$4,241 less than the cost for a rendering-only fish handling network. In **addition**, this project maintained the highest value end-use of the harvested resource. We, therefore, recommend continuation of the food-grade network as a component of the fish handling system.
3. The total spent for the fish handling system in 1994 was \$156,881. With cost recovery from sale of food-grade fish, the net cost for the fish handling system was \$148,204.

Report F
Development of a Systemwide Predator Control Program:
Indexing and Fisheries Evaluation

1. Objectives in 1994 were to (1) **evaluate** exploitation rate, size composition and incidental catch of northern **squawfish** captured in the various fisheries and estimate reductions in predation on juvenile **salmonids** since implementation of the management **program**; and (2) evaluate changes through 1994 in relative abundance, smelt consumption rate, size and age structure, growth, and **fecundity** of northern **squawfish** in lower Columbia and Snake River reservoirs and in the Columbia River downstream from Bonneville Dam.
2. Systemwide exploitation of northern **squawfish** in 1994 was 10.9% for sport-reward, 1.1% for dam-angling, and 1. **1%** for site-specific fisheries. **Subsamples** from each fishery indicated that the mean fork length was 344 **mm** in the sport-reward fishery, 401 mm in the dam-angling **fishery**, and 410 mm for gill nets in the site-specific fishery. ByCatch of **salmonids** was relatively low in all fisheries and was lowest **in** the dam-angling fishery relative to the tota! number of fish caught.
3. In general, relative abundance of northern **squawfish** in 1994 was similar to previous years in the Columbia River downstream from **Bonneville Dam**, but decreased in Columbia and Snake River reservoirs.

4. Potential predation on juvenile **salmonids** in 1995 maybe reduced 32% from **pre-program** levels. **Eventual** reductions in potential predation varied depending on estimates of sustained exploitation however, it appeared feasible to reduce overall predation by at least **40%**. **Smolt** consumption indices decreased in Columbia River **reservoirs** and remained similar or increased in Snake River reservoirs and the Columbia River downstream from Bonneville Dam by approximately 30-60% in some areas.
5. Proportional stock density (**PSD**) of northern squawfish collected from the Bonneville Dam **tailrace** was lower in 1994 than in 1990. Estimates of PSD from 1991-1994 were generally below levels that would have been expected without implementation of the Northern Squawfish Management Program. Relatively strong recruitment in 1989 and 1990 **will** probably decrease PSD estimates in 1995 and 1996 as these relatively strong cohorts are recruited to “stock” size. Although length-age and fecundity-length relationships varied among years in some locations, we found no evidence of compensation by northern squawfish in any area.

SECTION 1. IMPLEMENTATION

Cooperators

Columbia Basin Fish and Wildlife Authority

S.P. Cramer and Associates, Inc.

Washington Department of Fish and Wildlife

Pacific States Marine Fisheries Commission

Columbia River Inter-Tribal Fish Commission

Report A

Implementation of the Northern Squawfish Sport-Reward Fishery in the Columbia and Snake Rivers

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1994 Annual Report

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ABSTRACT

Northern **squawfish** (*Ptychocheilus oregonensis*) harvest in 1994 totaled 129,434 fish returned to registration stations for payment (\$3 per northern squawfish 11 inches or greater). Northern **squawfish** harvest was 24% greater than 1993 (104,536), 31% less than 1992 (186,904) and 19% less than 1991 (159, 162). A total of 40,783 angler days were spent fishing for northern

squawfish in 1994 and 51% (20,795) of the registered anglers returned to registration stations for an exit interview. Effort in 1994 was lower than any of the three previous years. Catch per unit effort (CPUE) in 1994 was 3.17 (fish/angler day) and was significantly greater ($P=0.0001$) than any of the three previous years. An additional 7,707 northern squawfish under 11 inches were returned to registration stations.

Fork lengths were measured from 69,731 northern squawfish of which 66,498 were greater than or equal to 250 mm (approximately 11 inches total length). Mean fork length of northern squawfish greater than or equal to 11 inches total length, decreased from 1991 (350 mm) to 1994 (335 mm).

Registration station totals for game fish and unclassified fish species other than northern squawfish showed that no species of fish was excessively harvested by returning anglers. Of the total reported non-squawfish catch (4,269 fishes), anadromous salmonids (*Oncorhynchus* spp.) comprised 3.6% (156 fish), all salmonids comprised 5.1% (216 fish), bass (*Micropterus* spp.) comprised 32.6% (1,393 fish), walleye (*Stizostedion vitreum*) comprised 11.8% (502 fish), and channel catfish (*Ictalurus punctatus*) comprised 6.2% (263 fish). Many of these fish were being targeted when caught.

Non-returning angler estimates for harvest of game and unclassified fishes were obtained from a telephone survey. Harvest estimates included 1,730 northern squawfish ≥ 11 inches, 5,840 northern squawfish < 11 inches, 1,320 smallmouth bass (*Micropterus dolomieu*), 500 walleye, 80 steelhead (*Oncorhynchus mykiss*), 10 chinook salmon (*Oncorhynchus tshawytscha*), and 80 white sturgeon (*Acipenser transmontanus*). No species of fish was found to be excessively harvested by non-returning anglers.

The promotional programs implemented in 1994 contributed to an increase in catch from 1993 and to the program achieving its highest exploitation rate to date. By increasing the reward paid for northern squawfish and by modifying select promotional activities, the 1995 fishery should be able to exceed the totals seen for 1994.

A total of 27,935 northern squawfish were returned to the registration station at The Fishery, which also achieved the lowest cost per fish (\$1.36) of any of the 14 registration stations. The registration station in Umatilla showed the highest cost per fish (\$24.57). The overall cost per fish in 1994 was lower than for any of the previous years of the fishery.

INTRODUCTION

Northern squawfish (*Ptychocheilus oregonensis*) are the dominant predator of juvenile salmonids (*Oncorhynchus* spp.) in the lower Columbia and Snake River systems (Beamesderfer and Rieman 1991). Rieman and Beamesderfer (1990) demonstrated that predation on juvenile salmonids could be reduced by 50% with limited, but sustained (10-20%) exploitation of northern squawfish greater than 275 mm fork length. The Columbia River Northern Squawfish

Management Program began in 1990 with the goal of achieving a 10-20% annual exploitation of northern squawfish. The northern squawfish sport-reward fishery has the highest exploitation among fisheries in most areas (Knutsen et al. 1994). The sport-reward fishery encourages anglers to catch northern **squawfish** greater than or equal to 11 inches in total length by offering rewards and incentives.

Fourteen registration stations were operated on the Columbia and Snake rivers in 1994. Purposes of the registration stations were to register anglers, issue pay vouchers for northern squawfish greater than or equal to 11 inches, conduct exit interviews and to collect biological data on a **subsample** of fishes. Pay vouchers issued to anglers contained a questionnaire designed to collect **harvest** information and to determine angler satisfaction with the sport-reward fishery. Exit interviews provided additional harvest information from returning anglers. Anglers not returning to the registration station were surveyed by telephone.

New promotional and incentive programs were designed, implemented and evaluated in 1994. These programs were designed to boost angler participation and increase exploitation of northern **squawfish** greater than 11 inches.

Registration stations with limited hours of operation (satellite stations) were evaluated to determine their operational feasibility.

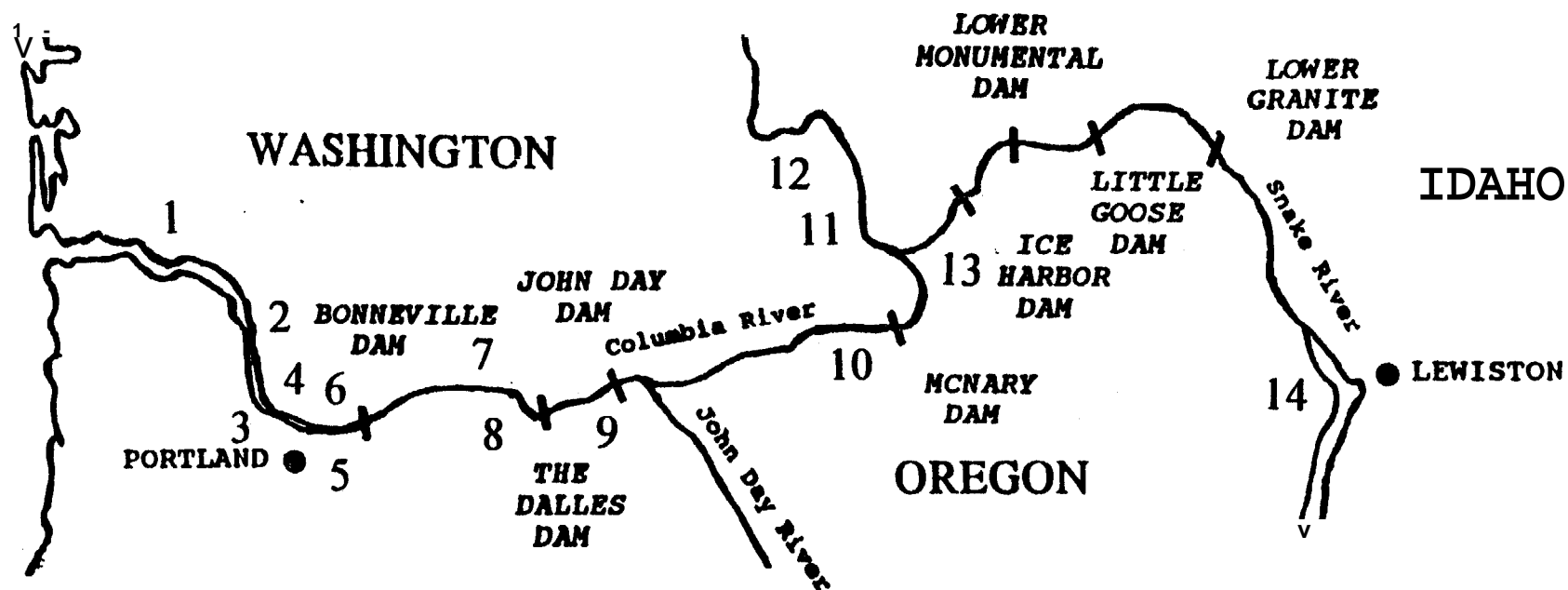
We examined the effectiveness of registration stations to **identify** and develop new operational methods that would lower costs. In doing so, we made a tremendous effort to ensure that our method of figuring costs was comparable to Susan **Hanna's**, who was responsible for the cost analysis following the 1992 and 1993 fishery seasons.

METHODS

Study Area

The northern **squawfish** sport-reward fishery was conducted from the mouth of the Columbia River to the boat restricted zone of Priest Rapids **Dam**, and from the mouth of the Snake River to the boat restricted zone of Hells Canyon Dam. Backwaters, sloughs and 400 feet inside the mouths of tributaries were also open for the harvest of northern **squawfish** for payment. Fourteen registration stations were located on the lower Columbia and Snake rivers (Figure 1).

A "**tailrace**" was defined as the section of river immediately below a dam. A "**reservoir**" was defined as the section of river from the **tailrace** of an upstream dam to the next downstream dam. The section of river below Bonneville Dam to the mouth of the Columbia River was defined as "downstream from Bonneville Dam."



1. Cathlamet Marina
2. Kalama Marina
3. M. James Gleason Boat Ramp
4. Washougal Boat Ramp
5. The Fishery at Covert's Landing

6. Hamilton Island
7. Bingen Marina
8. The Dalles Boat Ramp
9. Giles French Boat Ramp
10. Umatilla Marina

11. Columbia Point Park
12. Vernita Bridge
13. Hood Park
14. Greenbelt Boat Ramp

Figure 1. Location of the Northern **Squawfish** Sport-Reward Fishery registration stations on the Columbia and Snake rivers during the 1994 field season.

Participation Requirements

Angler compliance rules for 1994 were adopted as follows:

- A) Each angler must register in **person**, prior to **fishing**, at one of the registration stations each fishing day. A fishing day is a 24-hour period **from** 9 p.m. through 9 p.m. of the following day.
- B) Each angler, in **person**, must exchange his or her eligible northern squaw-fish for a voucher between the hours of 1 p.m. and 9 p.m. at the same registration station where the angler is registered during the same fishing day.
- C) To be eligible for a voucher, each northern squawfish must be **11** inches or longer in total length and be presented in fresh condition or **alive**.
- D) **Anglers** shall provide **information** regarding their harvest as requested by department personnel at the registration site and mail-in survey forms.
- E) Anglers **shall** obtain a Washington Oregon or Idaho state fishing license to fish for northern **squawfish** and must use a single rod, reel and line with up to three hooks with no more than three points.

Registration interview

Washington Department of Fish and Wildlife (**WDFW**) technicians were present to register anglers from 1 p.m. to 9 p.m. daily. **Anglers** could self-register at a registration box near the site between 9 p.m. and 1 p.m. daily. A short registration form was completed to record **information** pertinent to the anglers fishing day.

Northern Squawfish Data

We compared overall harvest, harvest by registration **station**, effort and CPUE by year, 1991-1994. Fork lengths were compared by reservoir and year, 1991-1994, using SAS general linear model.

Northern Squawfish Processing

All reward-sized northern **squawfish** were tail-clipped to indicate processing by a WDFW technician. Each northern **squawfish** was graded (food grade sites only) according to guidelines provided by **S.P. Cramer and Associates** to determine whether a fish would be processed as “food-grade” or “fertilizer-grade.” At the end of each **shift**, technicians delivered the fish to a designated facility for processing or storage by facility personnel.

Satellite Stations

Satellite stations were tested by intermittent scheduling of technicians to use existing vehicles for registration station operation. Satellite stations were operated daily for the following dates and times: (1) Boyer Park- June 20-July 31 (5 p.m. to 7 p.m.), (2) Ridgefield - July 4 (12 p.m. to 4 p.m.), (3) Rainier- July 29-September 11 (**12:30** p.m. to 2 p.m.), (4) Willow Grove - July 29-September 11 (**2:30** p.m. to **4:30** p.m.), (5) Grays River- July 29-September 11 (**5:30** p.m. to **7:30** p.m.), (6) Cascade Locks - July 18-September 11 (self-registration only 9 p.m. to 1 p.m.) and (7) Hood River - August 15-September 11 (self-registration only 9 p.m. to 1 p.m.). See Appendix A for satellite station locations.

RESULTS AND DISCUSSION

Harvest Data

The 1994 total harvest of northern squawfish eligible for payment was 129,434 fish and ranged **from** 19 fish in Ice Harbor Reservoir to 71,236 fish below Bonneville Dam (**Figure 2**). Northern **squawfish** harvest was 24% greater in 1994 than in 1993 (104,536), 31% less than 1992 (186,904) and 19% less than 1991 (159,162). Exploitation for the sport-reward fishery was greater in 1994 (10.9'XO) than in any previous year (Knutsen et al. 1995). An increased harvest in 1994 from 1993 may have been due to more favorable river conditions late **in** the sport-reward fishery season. Six registration stations (**Cathlamet, Gleason, Camas, The Fishery, Vernita and Greenbelt**) remained open for an additional two weeks yielding a harvest of 9,355 northern **squawfish**. These stations remained open due to increased northern **squawfish** harvest, continued participation from experienced anglers, and favorable river conditions. Northern **squawfish** harvest from the last five weeks (24,328), plus the **two-week**, six-site extension (9,355 fish), represented the major increase in harvest from 1993 (**Figure 3**). Anglers participating in the 1994 **sport-reward** fishery **often** complained to technicians that increased flow **early** in the season was decreasing their northern **squawfish** harvest. Low water conditions late in the season may have concentrated northern **squawfish**, making them more vulnerable. The systemwide mean weekly harvest in 1994 was 6,164 northern **squawfish** and ranged from 3,700 to 10,926 fish (**Figure 3**). Harvest varied by week from 1991-1994, but peak harvest occurred prior to July 15 in **all** years (**Figure 3**). Variation in spawning time could partially explain the difference in peak **harvest** among years. Northern **squawfish** aggregate in spawning areas prior to spawning (**Patten and Rodman 1969**). **Anglers** have informally reported to technicians that northern squawfish feed more aggressively prior to spawning, which could make them more vulnerable to angling prior to July 15. Variation in environmental factors such as water temperature and flow conditions also contributes to variation in peak harvest timing.

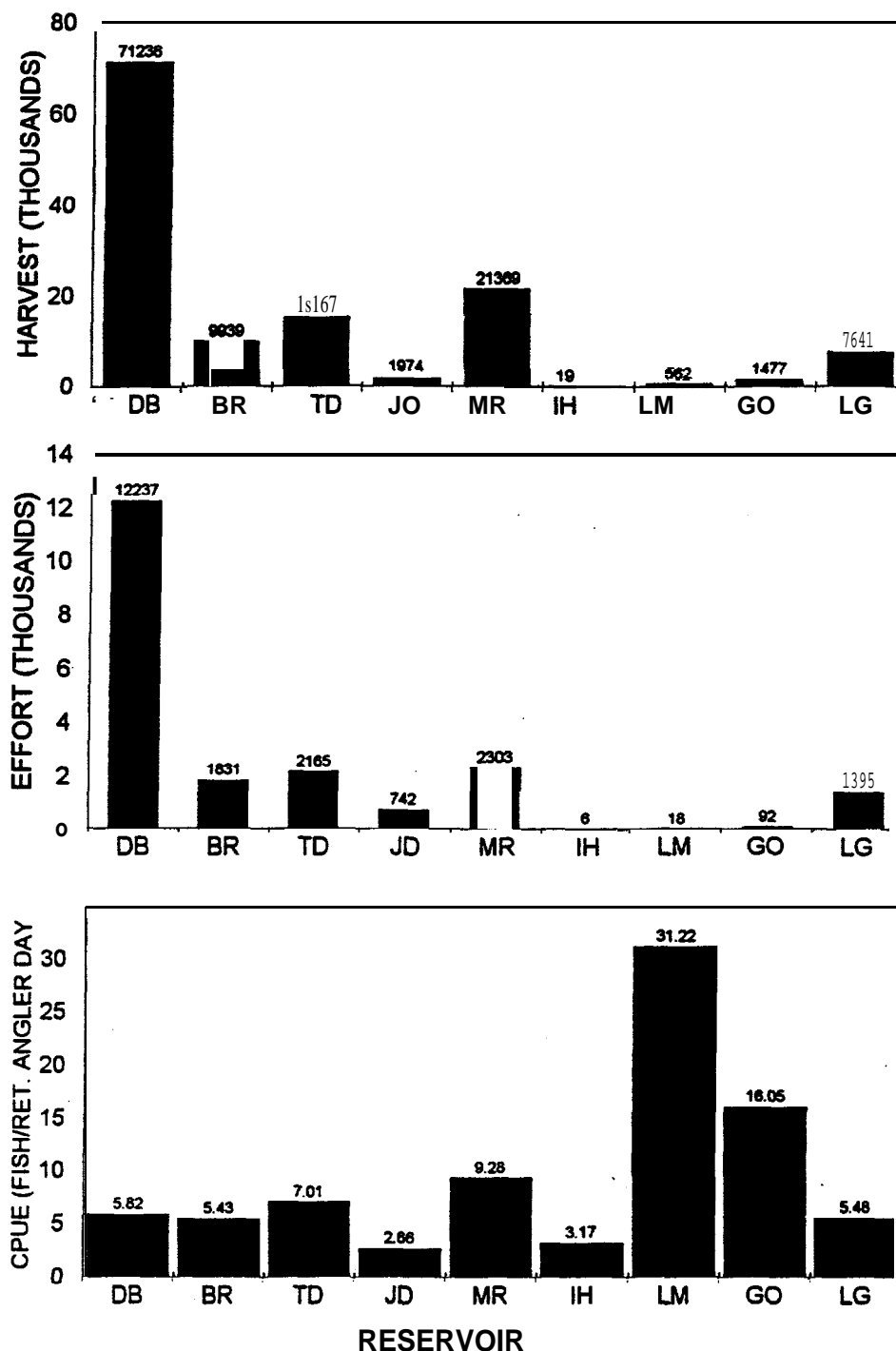


Figure 2. Northern squawfish harvest, effort (returning angler days) and CPUE (fish/returning angler day) by reservoir in 1994. DB - Downstream from Bonneville Dam, BR - Bonneville Reservoir, TD - The Dalles Reservoir, JD - John Day Reservoir, MR - McNary Reservoir, IH - Ice Harbor Reservoir, LM - Lower Monumental Reservoir, GO - Little Goose Reservoir, LG - Lower Granite Reservoir.

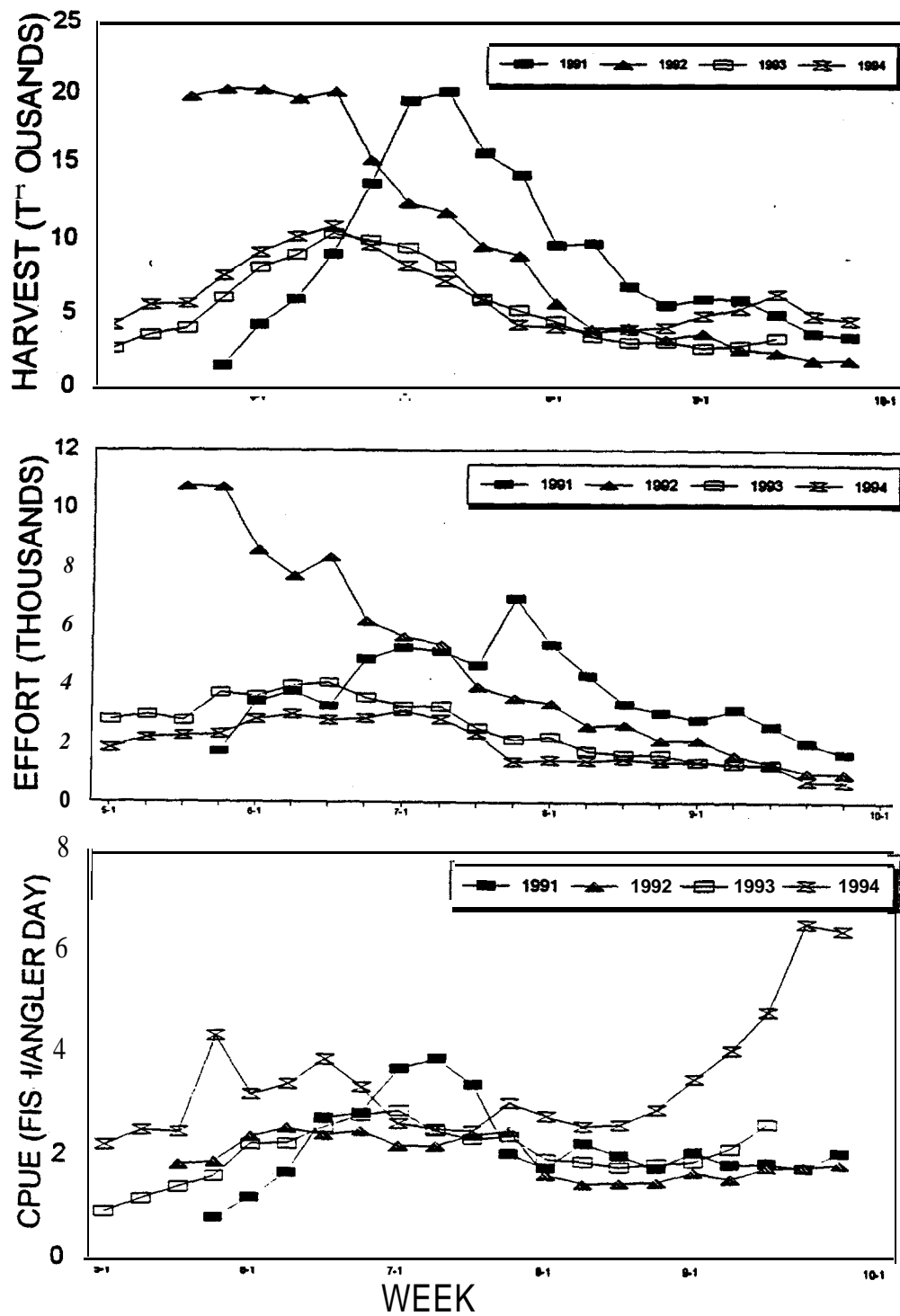


Figure 3. **Northern squawfish** harvest, effort (angler days) and CPUE (Fish/angler day) by week, 1991-1994.

Mean harvest of northern **squawfish** by registration station in 1994 was 9,129 fish and ranged from 1,586 fish at **Umatilla** Boat Ramp to 27,935 fish at The **Fishery** (Figure 4). Northern **squawfish** harvest in 1994 continued to be poor at **Umatilla** Boat Ramp in John Day Reservoir. Continued angler participation and lower program costs can be attained by converting this registration station to a satellite station. Twelve of the 14 registration stations in 1994 showed an increase in harvest of northern **squawfish** from 1993. Two registration stations, The **Dalles** and **Umatilla**¹, had greater harvests than in the three previous years, whereas The **Fishery** had a greater harvest than in 1993 or 1992. In comparison to 1993, The **Fishery** had the greatest percent increase in harvest (**71%**) of northern squawfish (Table 1).

Northern **squawfish** harvest was highest (43,846) in Fishing Location 10 (Table 2), which extends from Bonneville Dam downstream to Reed Island (Appendix Table A-2). **Harvest** from Fishing Locations 9 (14,264), 10 (43,846) and 16 (12,472; 6% of the fishing locations) accounted for approximately **55%** of the total harvest (Table 2). The top 10 fishing locations (Table 2; 20% of the fishing locations) that produced the greatest harvest of northern squawfish ranged from 2,757 to 43,846 fish and accounted for 76% of the total harvest eligible for payment (Table 2).

In addition, 7,707 northern **squawfish** less than 11 inches were returned to registration stations for no payment.

Exit Interview Harvest Data for Game, Food and Unclassified Fish Species

The sampling method for returning angler harvest in 1994 was more complete than previous years. From 1991-1993, anglers were required to show their incidental catch to the technician before the fish could be recorded. Anglers often **did** not wish to take the time to show their catch and consequently many fish went unrecorded. In 1994, anglers were not required to show their catch at the exit interview, which resulted in a more complete census of angler harvest. The 1994 harvest estimates were approximately twice as high as any of the previous years estimates. Due to sampling differences, the annual harvest estimates should not be considered comparable (Table 3).

Exit interview data showed **smallmouth** bass to be the most frequently harvested fish other than northern **squawfish** (Table 3). American shad (*Alosa sapidissima*) were second followed by **peamouth** chub (*Mylocheilus caurinus*) and walleye (Table 3). All 561 **peamouth** chub were harvested incidentally (while targeting northern **squawfish**). Efforts will be made in 1995 to educate anglers on how to distinguish between **peamouth** and northern squawfish to reduce their incidental harvest. We also **observed** harvest of a suspected hybrid between northern **squawfish** and **chislemouth** (Columbia River chub). Data will be collected in 1995 on these suspected hybrids to **verify** their parentage, determine if they are **piscivorous** and then decide if they should be included in all reward programs.

¹ Plymouth Boat Ramp harvest totals for 1991 and 1992 are used to represent **Umatilla** for this comparison.

Salmonid harvest was low for all species (Table 3). Beginning with the 1994 season, juvenile **salmonids** were distinguished from mature salmonids, but juvenile **salmonids** were not differentiated by species. Large numbers of juvenile hatchery steelhead pass through the Snake River near **Clarkston** in Lower Granite Reservoir. A portion of these juveniles **residualize** in the Snake River near **Clarkston**. In 1994, 85% of the 114 juvenile **salmonids harvested** came from Lower Granite Reservoir. Since these fish were not expected to survive, **WDFW** opened a fishery for these juveniles over 10 inches long. We cannot say with absolute certainty that 100% of the 1994 juvenile **harvest** consisted of juvenile hatchery steelhead, but the technicians who worked at the **Clarkston** registration station (**Greenbelt**) do not recall any of these fish being species other than juvenile hatchery steelhead. All juvenile **salmonids** will be classified to species in the 1995 northern **squawfish** sport-reward fishery and legally caught juveniles will be excluded from the harvest estimates.

Exit interview data is combined with voucher data in the harvest evaluation section of this report (Appendix F) to create a more accurate estimate of returning angler harvest. The 1995 returning angler sampling methods are discussed in Appendix F also.

Effort

Effort for 1994 was 40,783 angler days and ranged from six angler days in Ice Harbor Reservoir to 12,237 angler days in Bonneville **Tailrace** (Figure 2). There were no registration stations open in Ice Harbor or Lower Monumental Reservoirs in 1994, however, the reservoirs were open to participation. Effort was lower in 1994 than **all** previous years, indicating a need for increased participation coinciding with peak **CPUE** (Figure 3). Effort in 1994 was 18% lower than 1993 (50,034), 54% lower than 1992 (88,494) and 39% lower than 1991 (67,384).

Mean angler effort by week was 1,943 angler days and ranged from 704 to 3,102 angler days (Figure 3). Mean effort by registration station was 2,913 angler days and ranged from 1,359 at Columbia Point to 6,275 angler days at The Fishery (**Figure 4**). Effort (returning angler days) by fishing location (fishing location could only be recorded for anglers returning to the station) was highest in Locations 9 (3,346), 10 (5,927) and 16 (1,730; Table 2), which coincided with the top three harvest locations.

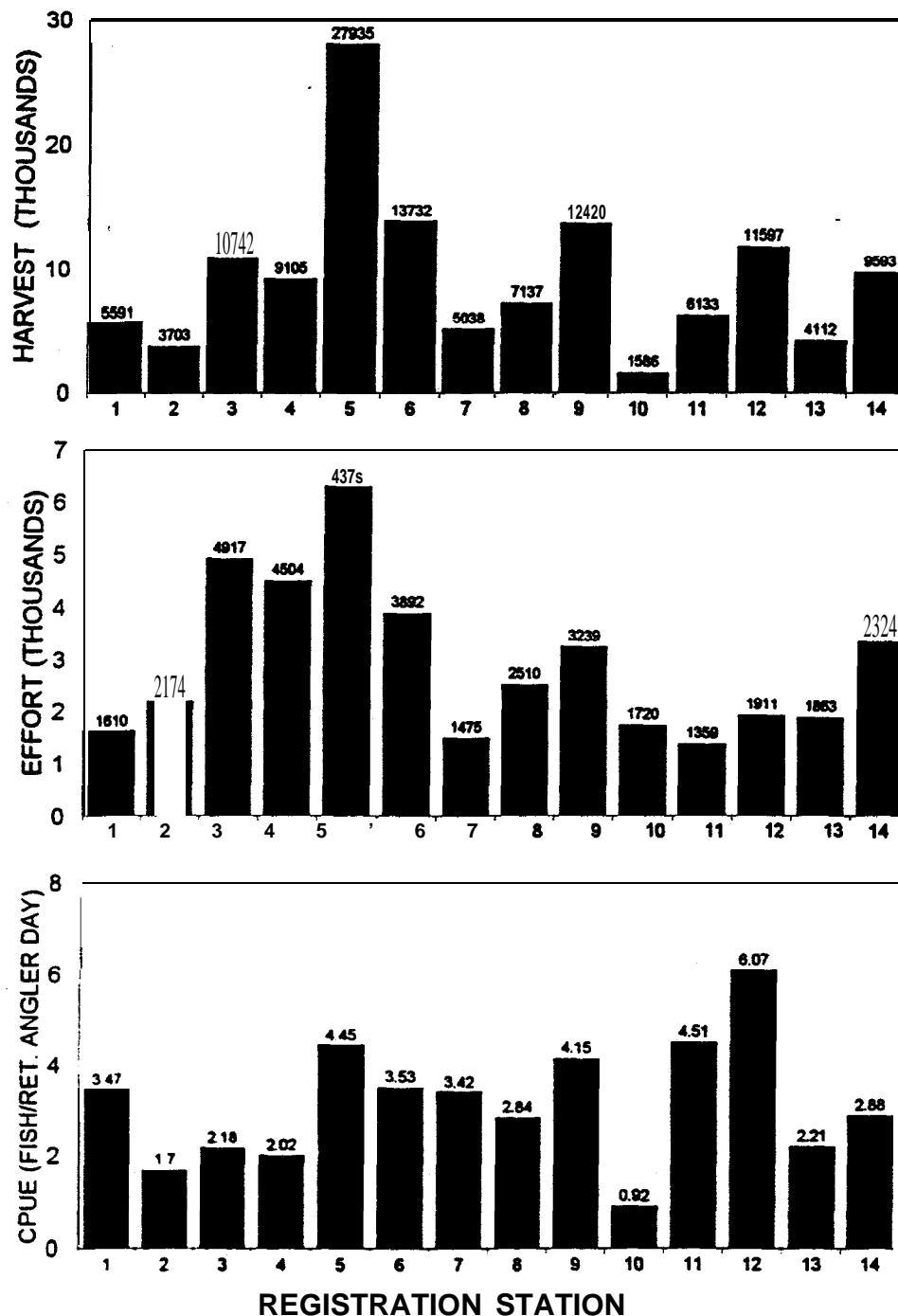


Figure 4. Northern **Squawfish** Harvest, **effort** and CPUE (fish/ returning angler day) by **registration** location in 1994. 1 - **Cathlamet**, 2 - **Kalama**, 3 - **Gleason**, 4 - **Camas**, 5 - **The Fishery**, 6 - **Hamilton Is.**, 7 - **Bingen**, 8 - **The Dalles**, 9 - **Giles French**, 10 - **Umatilla**, 11 - **Columbia Point**, 12 - **Vernita**, 13 - **Hood Park**, 14 - **Greenbelt**.

Table 1. Number of NSF greater than or equal to 11 inches returned to registration stations, 1991-1994.

| <u>Station</u> | <u>1991</u> | <u>1992</u> | <u>1993</u> | <u>1994</u> |
|-------------------------------|--------------------|--------------------|--------------------|--------------------|
| Hamilton Island | 18219 | 17048 | 9126 | 13732 |
| The Fishery | 40674 | 23851 | 16308 | 27935 |
| Cascade Locks | 9143 | 6779 | 1881 | -- |
| Bingen Marina | 12711 | 12513 | 6408 | 5038 |
| Dalles Boat Basin | 3828* | 6806 | 4338 | 7137 |
| LePage Park | 32141 | 16926 | 10643 | -- |
| Columbia Point Park | 1104* | 11148 | 5192 | 6133 |
| Hood Park | 3676* | 9199 | 4119 | 4112 |
| Lyons Ferry | 4211* | 3131 | 1466 | -- |
| Greenbelt Boat Ramp | 17466 | 21333 | 10309 | 9593 |
| Kalama Marina | -- | 6799 | 1605 | 3703 |
| Gleason Boat Ramp | -- | 15494 | 9719 | 10742 |
| Boyer Park | -- | 5875 | 1296 | -- |
| Cathlamet Marina | -- | -- | 3960 | 5591 |
| Rainier Boat Ramp | -- | -- | 1561 | -- |
| Camas/Washougal Boat Ramp | -- | -- | 5920 | 9105 |
| Umatilla Boat Ramp | -- | -- | 1000 | 1586 |
| Vernita Rest Area | -- | -- | 9765 | 11597 |
| Maryhill State Park | 1001* | 5074 | -- | -- |
| Plymouth Boat Ramp | 5556 | 2414 | -- | -- |
| Windust Park | 919* | -- | -- | -- |
| Central Ferry State Park | 7845 | -- | -- | -- |
| Chief Timothy State Park | 1048 | -- | -- | -- |
| Willow Grove Park | -- | 5676 | -- | -- |
| Marine Park (Portco) | -- | 8637 | -- | -- |
| Ringold | -- | 5139 | -- | -- |
| Bayport Marina | -- | 1606 | -- | -- |
| Giles French | -- | -- | -- | 13430 |

* Stations did not open until July 15, 1991.

-- Not in operation.

Table 2. Northern squawfish harvest (11 inches or greater), effort (returning angler days) and CPUE (fish/returning angler d by reservoir and fishing location, 1994.

| RESERVOIR | FISHING LOCATION | NSF HARVEST | EFFORT | CPUE |
|------------------------------|------------------|-------------|--------|-------|
| Downstream from | 1 | 1116 | 216 | 5.17 |
| Bonneville Dam | 2 | 3318 | 523 | 6.34 |
| " | 3 | 2079 | 347 | 5.99 |
| " | 4 | 610 | 123 | 4.96 |
| " | 5 | 1521 | 510 | 2.98 |
| " | 6 | 70 | 34 | 2.06 |
| " | 7 | 447 | 60 | 7.45 |
| " | 8 | 3965 | 1151 | 3.44 |
| " | 9 | 14264 | 3346 | 4.26 |
| " | 10 | 43846 | 5927 | 7.4 |
| Bonneville Res. | 11 | 481 | 111 | 4.33 |
| " | 12 | 1273 | 185 | 6.88 |
| " | 13 | 2757 | 673 | 4.1 |
| " | 14 | 5428 | 862 | 6.3 |
| The Dalles Res. | 15 | 2695 | 435 | 6.2 |
| " | 16 | 12472 | 1730 | 7.21 |
| John Day Res. | 17 | 35 | 28 | 1.25 |
| " | 18 | 0 | 0 | 0 |
| " | 19 | 0 | 0 | 0 |
| " | 20 | 0 | 0 | 0 |
| " | 21 | 437 | 27 | 16.19 |
| " | 22 | 539 | 273 | 1.97 |
| " | 23 | 963 | 414 | 2.33 |
| McNary Res. | 24 | 21 | 16 | 1.31 |
| " | 25 | 1 | 4 | 0.25 |
| " | 26 | 19 | 16 | 1.19 |
| " | 27 | 75 | 55 | 1.36 |
| " | 28 | 546 | 185 | 2.95 |
| " | 29 | 2564 | 251 | 10.22 |
| " | 30 | 894 | 81 | 11.04 |
| " | 31 | 7176 | 305 | 23.53 |
| " | 32 | 4555 | 358 | 12.72 |
| " | 33 | 2851 | 472 | 6.04 |
| " | 34 | 0 | 0 | 0 |
| " | 35 | 2667 | 560 | 4.76 |
| Ice Harbor Res. | 36 | 4 | 3 | 1.33 |
| " | 37 | 0 | 0 | 0 |
| " | 38 | 15 | 3 | 5 |
| Lower Monumental Res. | 39 | 0 | 0 | 0 |
| " | 40 | 8 | 2 | 4 |
| " | 41 | 554 | 14 | 39.57 |
| Little Goose Res. | 42 | 271 | 12 | 22.58 |
| " | 43 | 0 | 0 | 0 |
| " | 44 | 1206 | 80 | 15.08 |
| Lower Granite Res. | 45 | 27 | 4 | 6.75 |
| " | 46 | 5 | 1 | 5 |
| " | 47 | 261 | 45 | 5.8 |
| " | 48 | 1415 | 394 | 3.59 |
| " | 49 | 2466 | 498 | 4.95 |
| " | 50 | 2724 | 420 | 6.49 |
| " | 51 | 743 | 33 | 22.52 |
| Totals | | 129384 | 20787 | |

Table 3. Total harvest of fishes, excluding NSF, that were reported during the exit interview.

| <u>Common Name</u> | <u>Code</u> | <u>1991</u> | <u>1 9 9 2</u> | <u>1993</u> | <u>1994</u> |
|----------------------|-------------|-------------|----------------|-------------|-------------|
| American shad | AMs | 6 | 54 | 28 | 776 |
| Black crappie, | BC | 44 | 3 | 0. | 13 |
| Blue catfish | BCF | 0 | 0 | 0 | 2 |
| Bluegill | BG | 3 | 3 | 0 | 10 |
| Bridgelip sucker | BRS | 9 | 8 | 0 | 25 |
| Brown bullhead | BBH | 8 | 18 | 7 | 21 |
| Bullhead (general) | BH | 4 | 4 | 10 | 2 |
| Bull trout | BLC | 1 | 0 | 0 | 0 |
| Carp | CP | 6 | 19 | 7 | 15 |
| Channel catfish | cc | 453 | 141 | 202 | 263 |
| Chinook Salmon | CK | 0 | 7 | 5 | 9 |
| Chiselmouth | CMO | 106 | 139 | 87 | 38 |
| Chum salmon | CH | 0 | 1 | 0 | 0 |
| Coho Salmon | co | 0 | 0 | 1 | 3 |
| Columbia River chub* | CRC | 192 | 125 | 316 | 253 |
| Crappie (general) | c | 23 | 3 | 4 | 3 |
| Cutthroat trout | CT | 5 | 0 | 0 | 2 |
| Cutthroat Lahontan | LCT | 0 | 0 | 0 | 1 |
| Juvenile salmonids | JVS | 0 | 0 | 0 | 114 |
| Kokanee | K | 0 | 0 | 0 | 1 |
| Largemouth bass | LMB | 3 | 9 | 2 | 5 |
| Longnose sucker | LNS | 0 | 1 | 0 | 0 |
| Largescale sucker | LRs | 4 | 11 | 7 | 4 |
| Peamouth | PMO | 368 | 588 | 702 | 561 |
| PumpkinSeed | Ps | 1 | 2 | 1 | 1 |
| Rainbow trout (res.) | RB | 25 | 9 | 7 | 8 |
| Rainbow trout (unk.) | RU | 20 | 113 | 2 | 4 |
| RedSide shiner | RS | 1 | 2 | 0 | 0 |
| Sandroller | SAN | 0 | 0 | 1 | 0 |
| Sculpin (general) | COT | 2 | 10 | 1 | 21 |
| Sculpin, Prickly | PRS | 0 | 1 | 0 | 0 |
| Sculpin, Torrent | TRS | 0 | 0 | 1 | 0 |
| Searun cutthroat | SCT | 0 | 1 | 2 | 1 |
| Smallmouth bass | SMB | 770 | 693 | 493 | 1388 |
| Sockeye salmon | SO | 0 | 2 | 0 | 0 |
| Starry flounder | SF | 2 | 9 | 2 | 27 |
| Steelhead (summer) | SS | 10 | 40 | 20 | 25 |
| Steelhead (unknown) | SH | 18 | 9 | 3 | 4 |
| Steelhead (winter) | Sw | 1 | 13 | 0 | 0 |
| Sucker (general) | SK | 11 | 21 | 3 | 18 |
| Tenth | TNC | 1 | 0 | 0 | 0 |
| Trout (unknown) | TR | 0 | 0 | 5 | 25 |
| walleye | WAL | 184 | 231 | 121 | 502 |
| Warmouth | WM | 2 | 0 | 0 | 0 |
| White crappie | wc | 20 | 0 | 1 | 3 |
| Whitefish, mountain | WF | 3 | 5 | 3 | 19 |
| White sturgeon | WS | 9 | 17 | 11 | 40 |
| Yellow bullhead | YBH | 0 | 0 | 9 | 5 |
| Yellow perch | YP | 43 | 36 | 16 | 57 |
| Totals | | 2358 | 2349 | 2100 | 4269 |

* probable NSF/CMO hybrid; named columbia river chub for this report.

Catch per Unit Effort

Catch per unit effort (**CPUE**) in 1994 was 3.17 (fish/angler day) and ranged from 2.66 (fish/angler day) in John Day Reservoir to 31.22 (fish/angler day) in Lower Monumental Reservoir (Figure 2). Overall CPUE was significantly higher ($P < 0.0001$) in 1994 than in 1993 (2.09 fish/angler day), 1992 (2.11 fish/angler day) or 1991 (2.37 fish/angler day). The high CPUE in 1994 maybe due to a decrease in participation by inexperienced anglers along with experienced anglers becoming more **successful** at catching northern **squawfish**. The 1994 CPUE indicates that northern squawfish can be readily **harvested** by veteran anglers and that increasing the number of experienced anglers **will** increase harvest totals. Mean CPUE by week was 3.40 (fish/angler day) with a range of 2.21 to 6.46 (fish/angler day, Figure 3). Mean CPUE by registration station was 3.17 (fish/angler day) and ranged from 0.92 (fish/angler day) at **Umatilla** Boat Ramp to 6.07 (fish/angler day) at Vernita (Figure 4). CPUE (fish/returning angler day) was highest in fishing locations 31 (23.53), 41 (39.57) and 42 (22.58; Table 2).

Fork Length Data

A total of 69,731 northern **squawfish** were sampled for fork length in 1994, of which 66,498 fish had a fork length greater than or equal to 11 inches. The mean fork length for northern squawfish greater than or equal to 250 mm was 335 mm and ranged from 323 mm in the Bonneville **tailrace** to 350 mm in The **Dalles** Reservoir (Table 4). Mean fork length of northern squawfish greater than 250 mm decreased significantly in 1994 (335 mm) from 1991 (350 mm; $P < 0.0001$), which concurred with the findings of the Oregon Department of Fish and Wildlife (Knutsen et al. 1995; Table 4). **Ice** Harbor and Lower Monumental reservoirs had lower mean fork lengths than Bonneville **tailrace**, but were not used in these comparisons due to a low sample size. Seven of nine reservoirs in 1994 showed a statistically significant decrease ($P < 0.0001$) in mean fork length from 1991 (Table 4). Little Goose Reservoir showed a significant increase ($P < 0.0001$) in mean fork length (345 mm) in 1994 over **all** previous years. Lower Granite Reservoir showed a significant decrease ($P < 0.0001$) in mean fork length (349 mm) from 1993 (260 mm). An increase in harvest of northern **squawfish** in areas of the Snake River Canyon accessible by jet boat only may have been responsible for part of this decrease. We also believe that large numbers of illegally harvested northern **squawfish** have been turned in at **Greenbelt** Boat Ramp in past years, which may have biased previous mean fork lengths for Lower Granite Reservoir. Factors such as year-class strength and gear bias **could** also contribute to yearly changes in reservoir mean fork lengths.

Registration and Exit Times

Anglers registered most frequently in 1994 between 7 a.m. and 8 a.m. (4,264 anglers) and between 9 p.m. and 10 p.m. (4,106 anglers). Both time **intervals** show a similar number of anglers registering and indicate that the most popular registration times are early in the morning or late in the evening.

In 1994, the most popular times for anglers to return to the registration stations with their catch were 8 p.m. to 9 p.m. (6,647 anglers/51,312 **squawfish**) and 1 p.m. to 2 p.m. (2,600 anglers/16,710 **squawfish**).

Satellite Stations

Operation of seven satellite stations resulted in minimal costs and succeeded with the use of existing vehicles and technicians. Evaluation of operating costs was not a primary concern during the 1994 test period, however, costs should be evaluated during the 1995 sport-reward fishery. Implementation of additional satellite stations in 1995 could increase **harvest** and participation in areas where extended travel deters anglers. Communication with anglers at registration stations and by telephone survey during the 1994 northern **squawfish** sport-reward fishery indicated that anglers would participate more in certain areas if registration stations were more conveniently located.

Northern **squawfish** harvest and effort (angler days) totals for the seven satellite stations operated in 1994 were: Boyer Park (278 **squawfish**/72 angler days), **Ridgefield** (4 **squawfish**/42 angler days), Rainier (961 **squawfish**/212 angler days), Willow Grove (269 **squawfish**/180 angler days), Grays River (25 **squawfish**/17 angler days), Cascade Locks (0 **squawfish**/8 angler days) and Hood River (95 **squawfish**/24 angler days) for a total harvest of 1,632 northern **squawfish**.

RECOMMENDATIONS FOR THE 1995 SPORT-REWARD FISHERY

1. Implement 15 satellite stations along the Snake and Columbia rivers (Table 5).
2. Convert **Umatilla** Boat Ramp to a satellite station. The station will operate from 6 p.m. to 8 p.m. daily as determined by the frequency of angler exits at **Umatilla** Boat Ramp during these hours in 1994.
3. **Field** operations should remain limited to one **shift** per day (e.g., 1 p.m. to 9 p.m.) seven days per week. Self-registration should continue to be available during **non-staffed** hours.
4. Location and number of registration stations should be placed **systemwide** at areas that will achieve highest harvest.
5. Continue a telephone **survey** to (1) evaluate incentive and promotional programs, (2) assess numbers of fish species **harvested** by non-returning anglers, and (3) evaluate program satisfaction.

Table 4. Mean fork length comparison by reservoir of **NSF** greater than 11 inches 1991-1994 (**P>f**) estimating the probability of the mean fork length being significantly different from 1991 to 1994.

| Reservoir | Year | n | mean | P>F |
|-----------------------------------|------|--------|------|--------|
| Downstream from Bonneville Dam | 1991 | 9698 | 341 | 0.0001 |
| | 1992 | 41842 | 334 | |
| | 1993 | 28047 | 321 | |
| | 1994 | 32577 | 323 | |
| Bonneville | 1991 | 7550 | 349 | 0.0001 |
| | 1992 | 8457 | 353 | |
| | 1993 | 6481 | 310 | |
| | 1994 | 4260 | 338 | |
| The Dalles | 1991 | 8563 | 371 | 0.0001 |
| | 1992 | 17043 | 364 | |
| | 1993 | 9101 | 364 | |
| | 1994 | 11564 | 350 | |
| John Day | 1991 | 2821 | 371 | 0.0001 |
| | 1992 | 2508 | 370 | |
| | 1993 | 956 | 365 | |
| | 1994 | 1746 | 343 | |
| McNary | 1991 | 4701 | 356 | 0.0001 |
| | 1992 | 17024 | 350 | |
| | 1993 | 13197 | 339 | |
| | 1994 | 10492 | 345 | |
| Ice Harbor | 1991 | 890 | 360 | 0.0001 |
| | 1992 | 4565 | 362 | |
| | 1993 | 45 | 350 | |
| | 1994 | 19 | 304 | |
| Lower Monumental | 1991 | 3642 | 319 | 0.0141 |
| | 1992 | 2897 | 309 | |
| | 1993 | 1586 | 313 | |
| | 1994 | 406 | 313 | |
| Little Goose | 1991 | 1902 | 337 | 0.0001 |
| | 1992 | 4748 | 330 | |
| | 1993 | 1147 | 337 | |
| | 1994 | 836 | 345 | |
| Lower Granite | 1991 | 19122 | 348 | 0.0484 |
| | 1992 | 19464 | 350 | |
| | 1993 | 9150 | 360 | |
| | 1994 | 6893 | 349 | |
| Combined Totals | 1991 | 59650 | 350 | 0.0001 |
| | 1992 | 119437 | 346 | |
| | 1993 | 68797 | 335 | |
| | 1994 | 68793 | 335 | |

Table 5. Satellite stations for the 1995 sport-reward program are shown along with the time of operation and the registration station responsible for their operation.

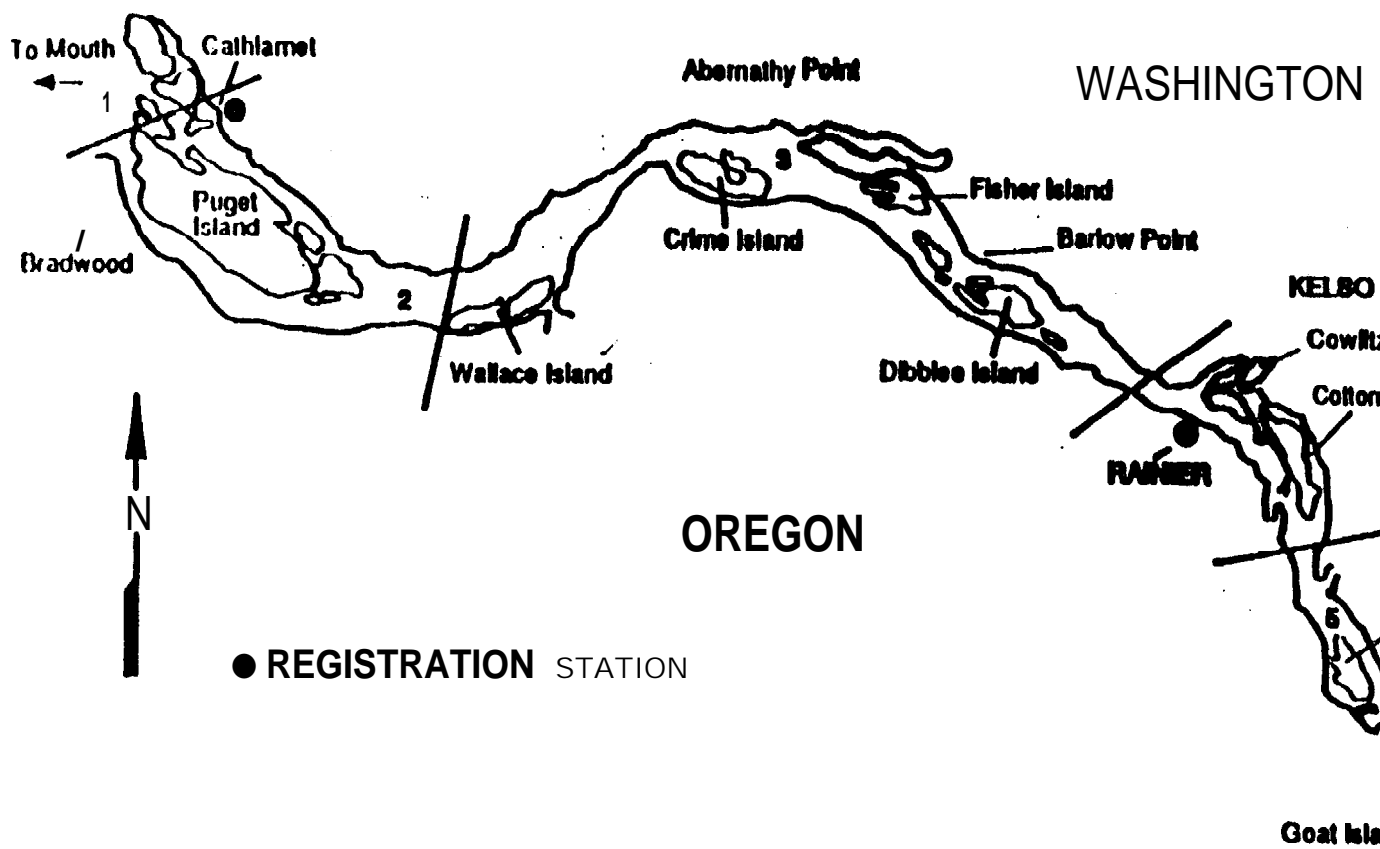
| REGISTRATION STATIONS | SATELLITE STATIONS | TIME |
|------------------------------|---------------------------|---------------|
| 1. CATHLAMET | JOHN DAY RAMP | 8:00-9:00am |
| CATHLAMET | DEEP RIVER | 9:30-10:30am |
| 2. KALAMA | WILLOW GROVE | 7:00-8:30am |
| KALAMA | RAINIER MARINA | 9:00-10:00am |
| KALAMA | SCAPPOOSE BAY MARINA | 10:30-11:30am |
| 3. GLEASON | CHINOOK LANDING | 7:00-8:30am |
| GLEASON | MARINE PARK (PORTCO) | 9:00-10:00am |
| GLEASON | RIDGEFIELD MARINA | 10:30-11:30am |
| 4. THE FISHERY | BEACON ROCK | 7:00-8:30am |
| THE FISHERY | HOME VALLEY | 9:00-10:00am |
| THE FISHERY | CASCADE LOCKS | 6:00-8:00pm |
| 6. BINGEN | HOOD RIVER MARINA | 7:00-8:00am |
| 7. THE DALLES | MARYHILL STATE PARK | 9:30-10:30am |
| 8. HOOD PARK | UMATILLA | 6:00-8:00pm |
| 9. CLARKSTON | BOYER PARK | 5:00-7:00pm |

REFERENCES

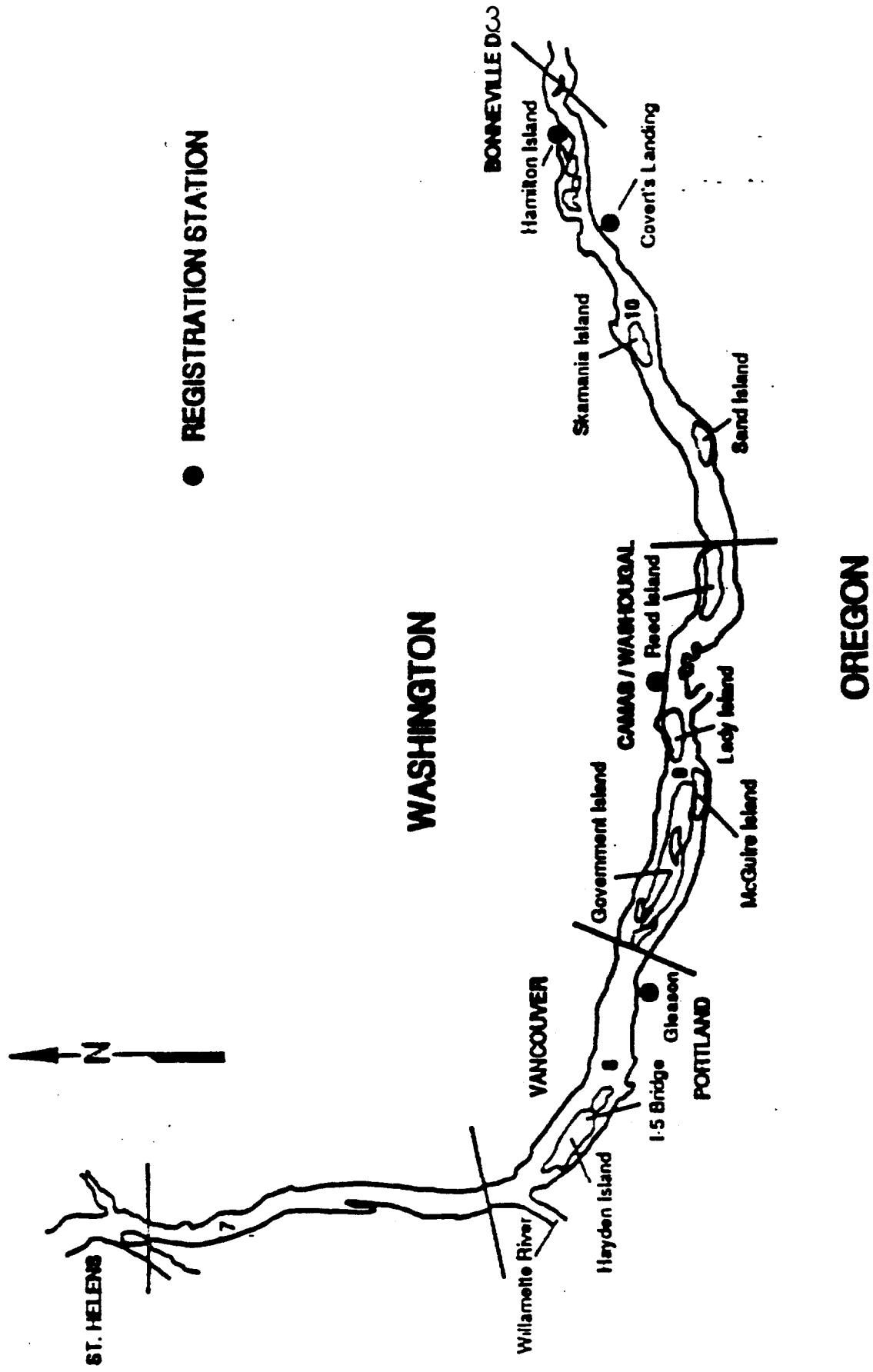
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APPENDIX A

Maps Showing Fishing Locations and Codes for the 1994 Sport-Reward Fishery

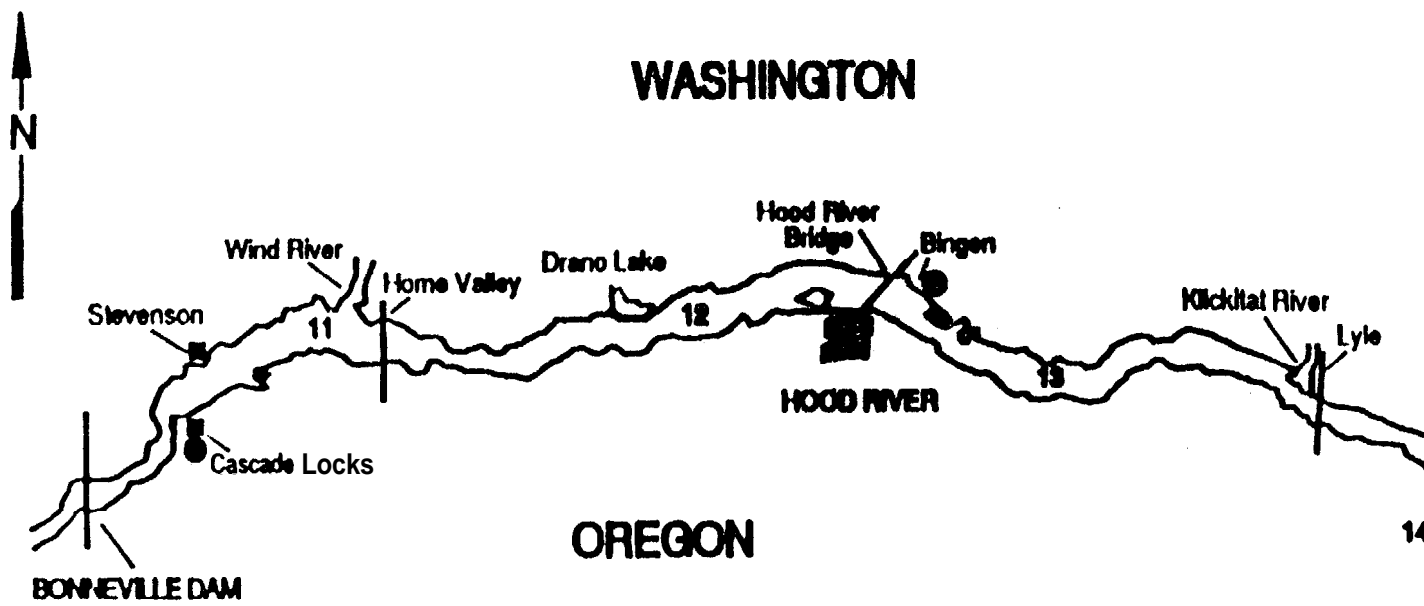


Appendix A-1. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, mouth of Columbia Ri

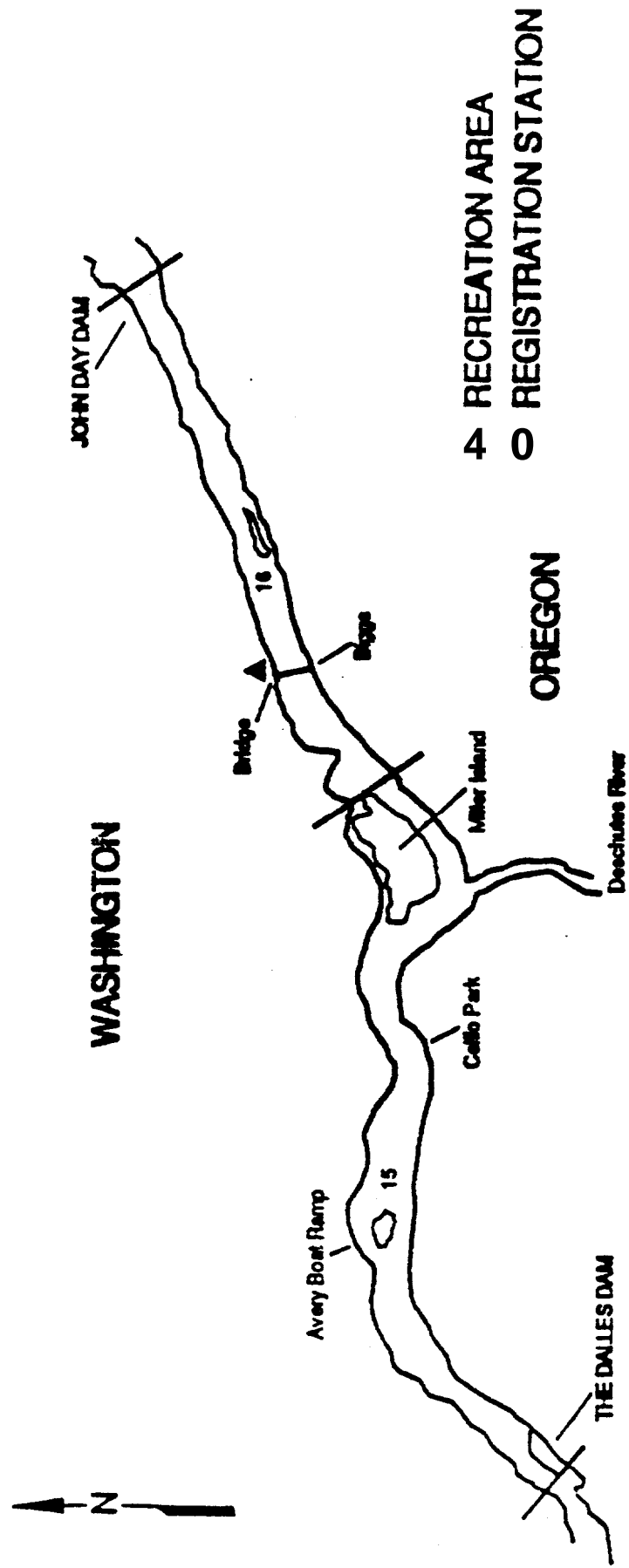


Appendix A-2. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, Lewis River to Bonneville Dam.

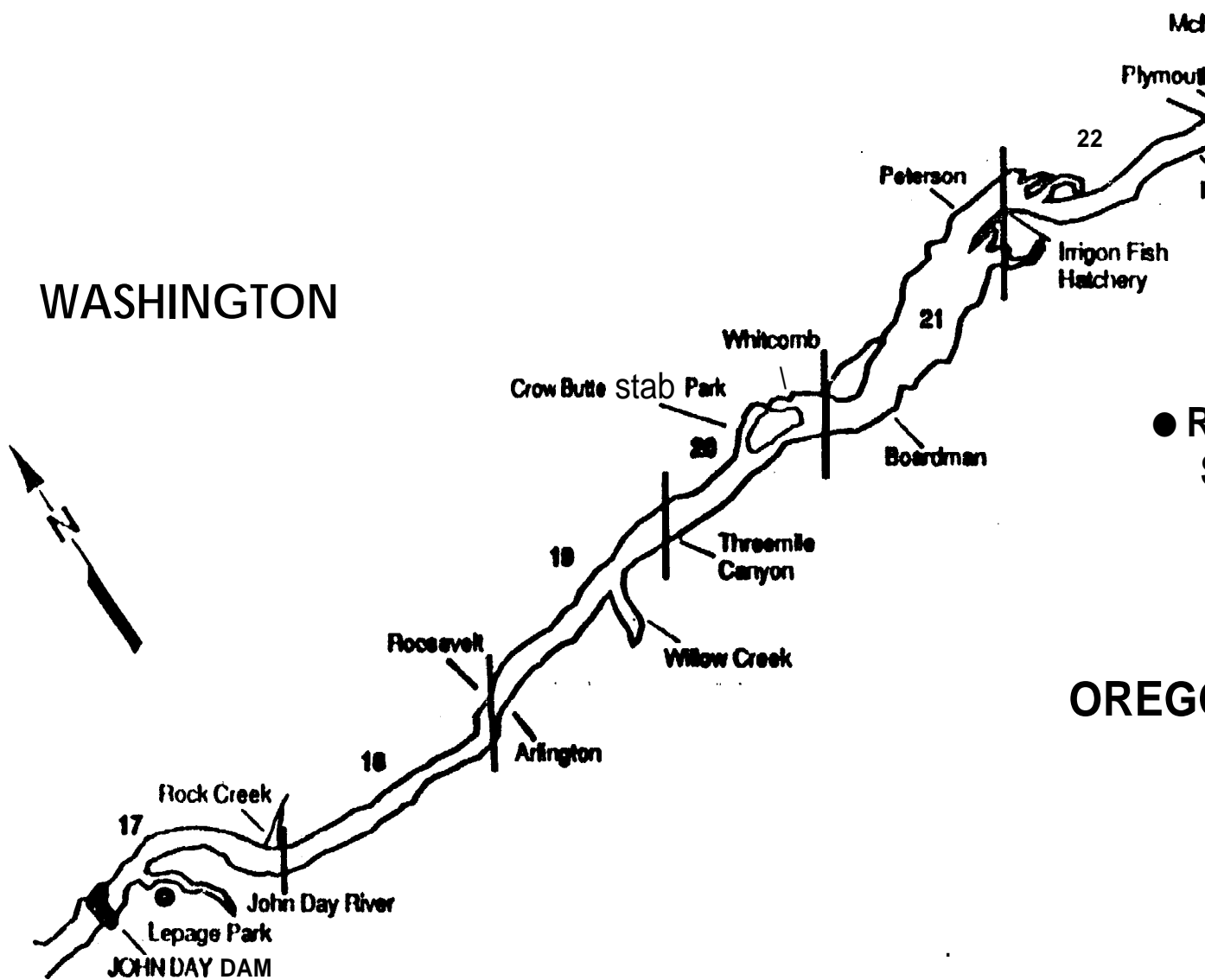
● REGISTRATION STATION



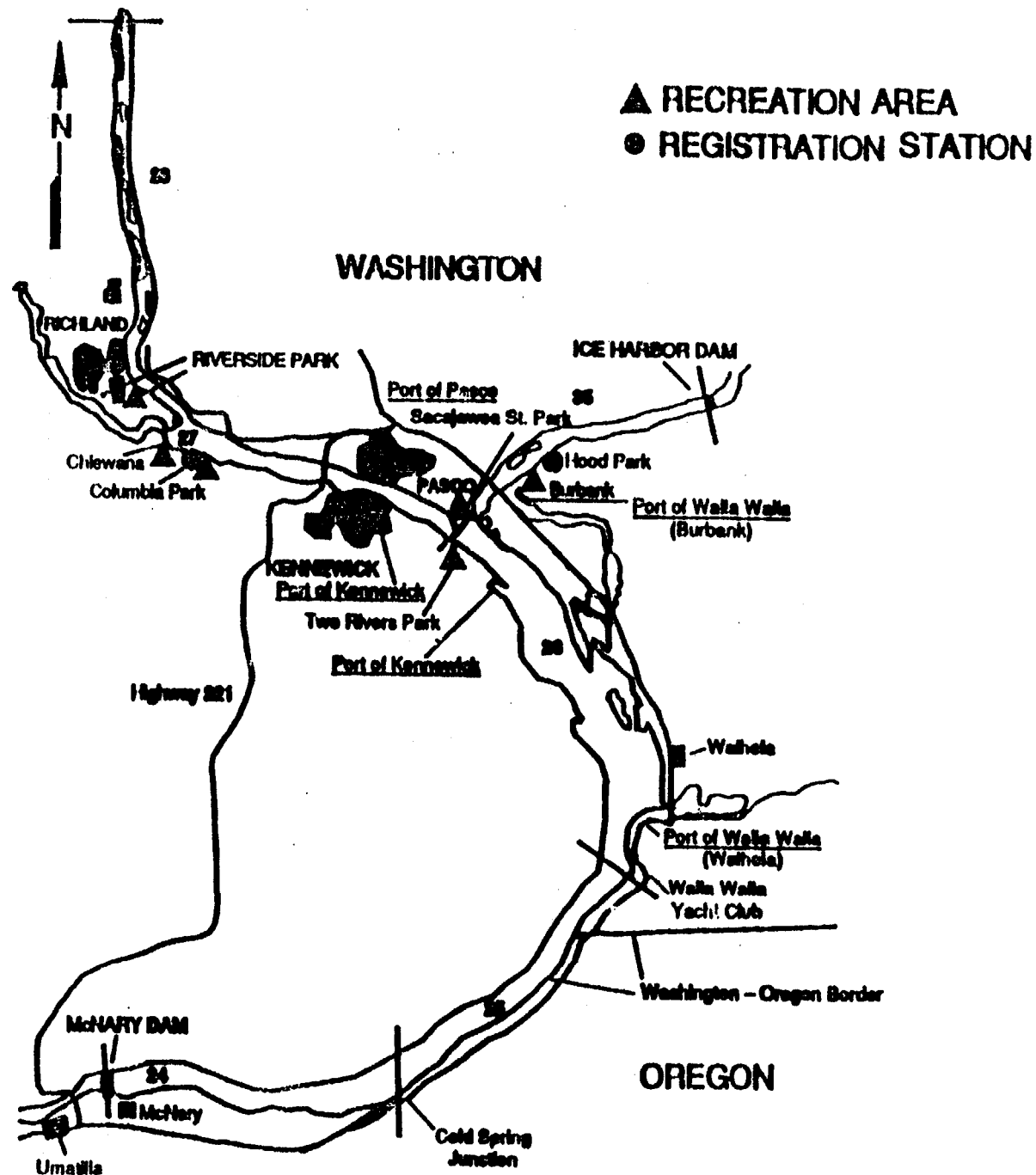
Appendix A-3. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, Bonneville Dam to T



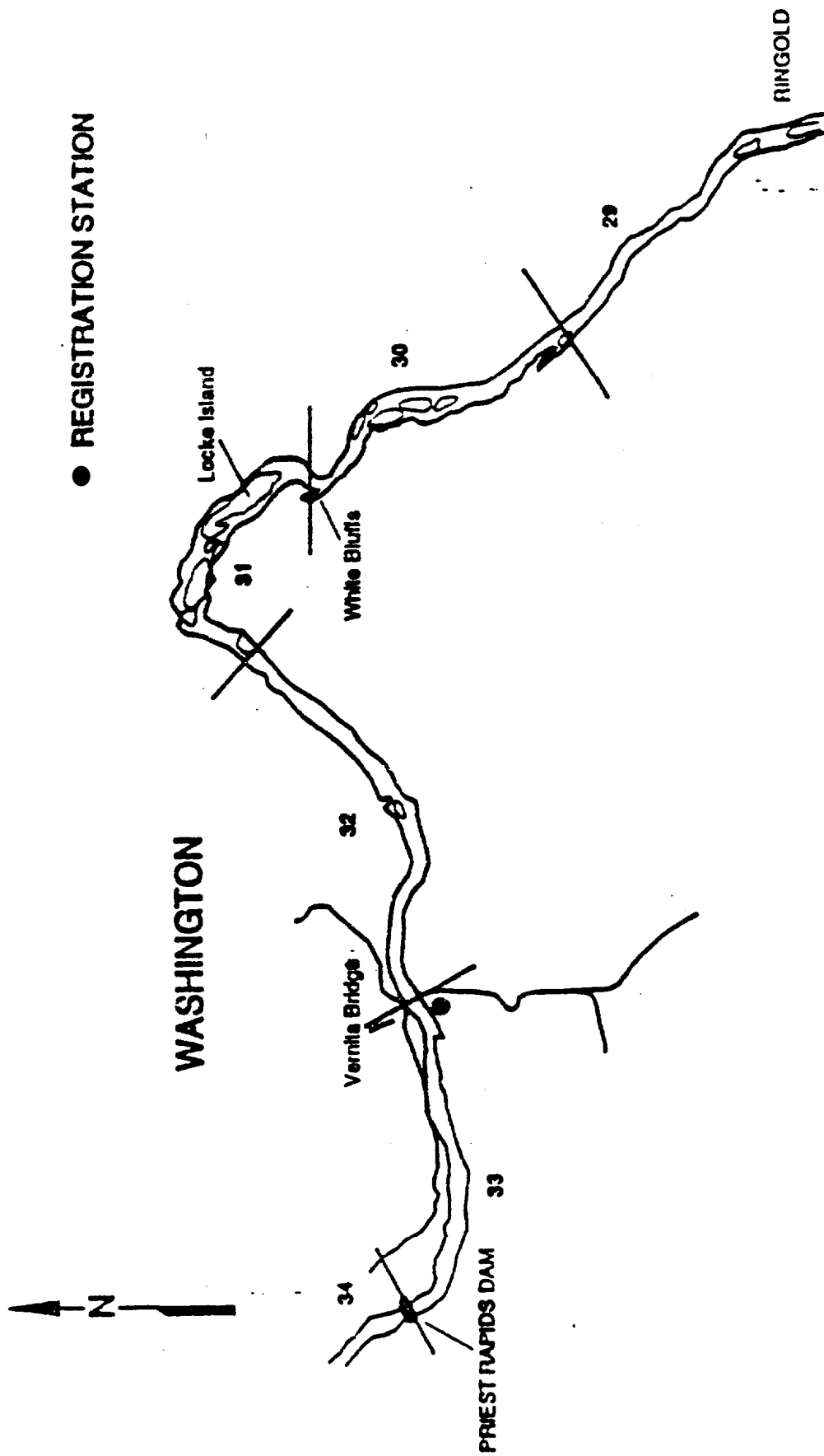
Appendix A-4. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, The Dalles Dam to John Day Dam.



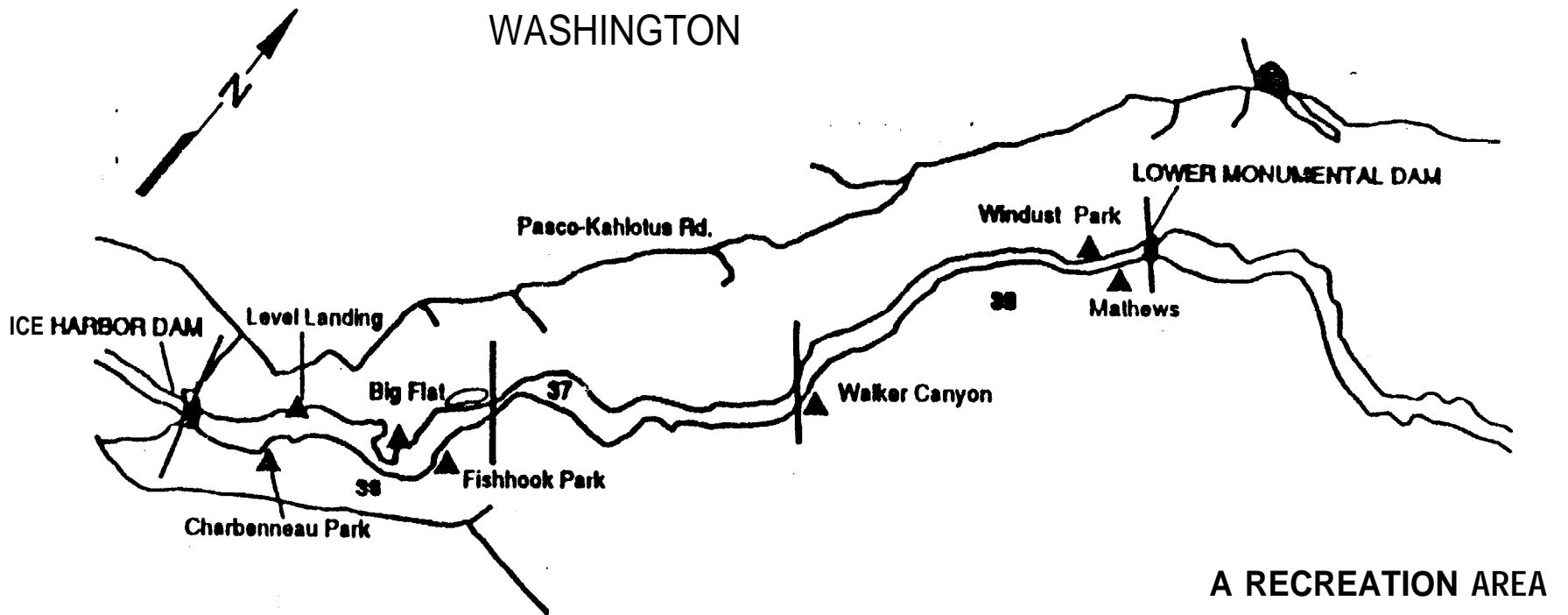
Appendix A-5. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, John Day Dam to McL



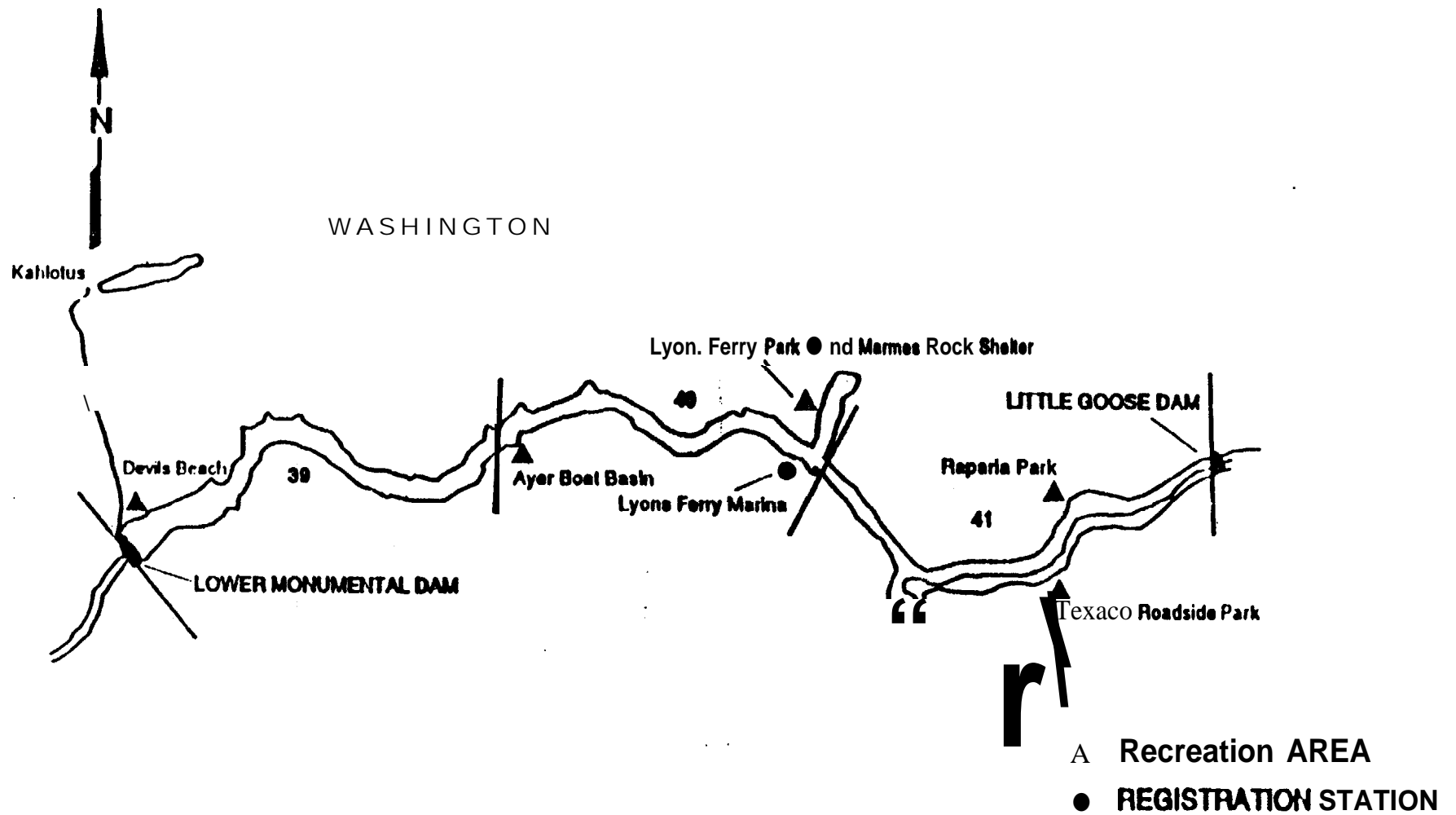
Appendix A-6. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, McNary Dam to Ringold Boat Ramp and mouth of Snake River to Ice Harbor Dam.



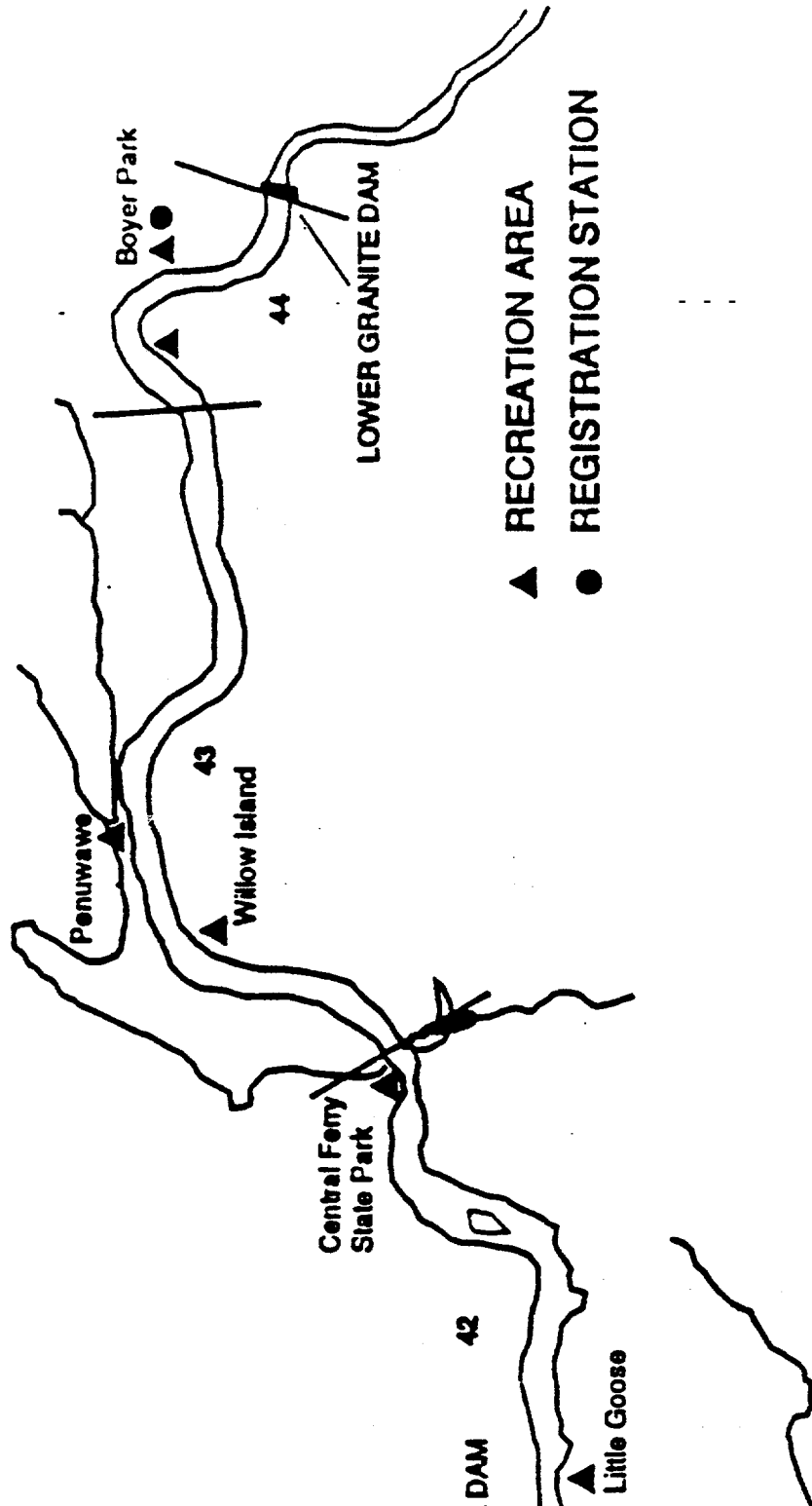
Appendix A-7. 1994 Northern Squawfish Sport-Reward Fishery fishing location codes, Ringold Boat Ramp to Priest Rapids Dam



Appendix A-8. 1994 Northern **Squawfish** Sport-Reward Fishery fishing location codes, Ice Harbor Dam to Lower Monumental Dam.

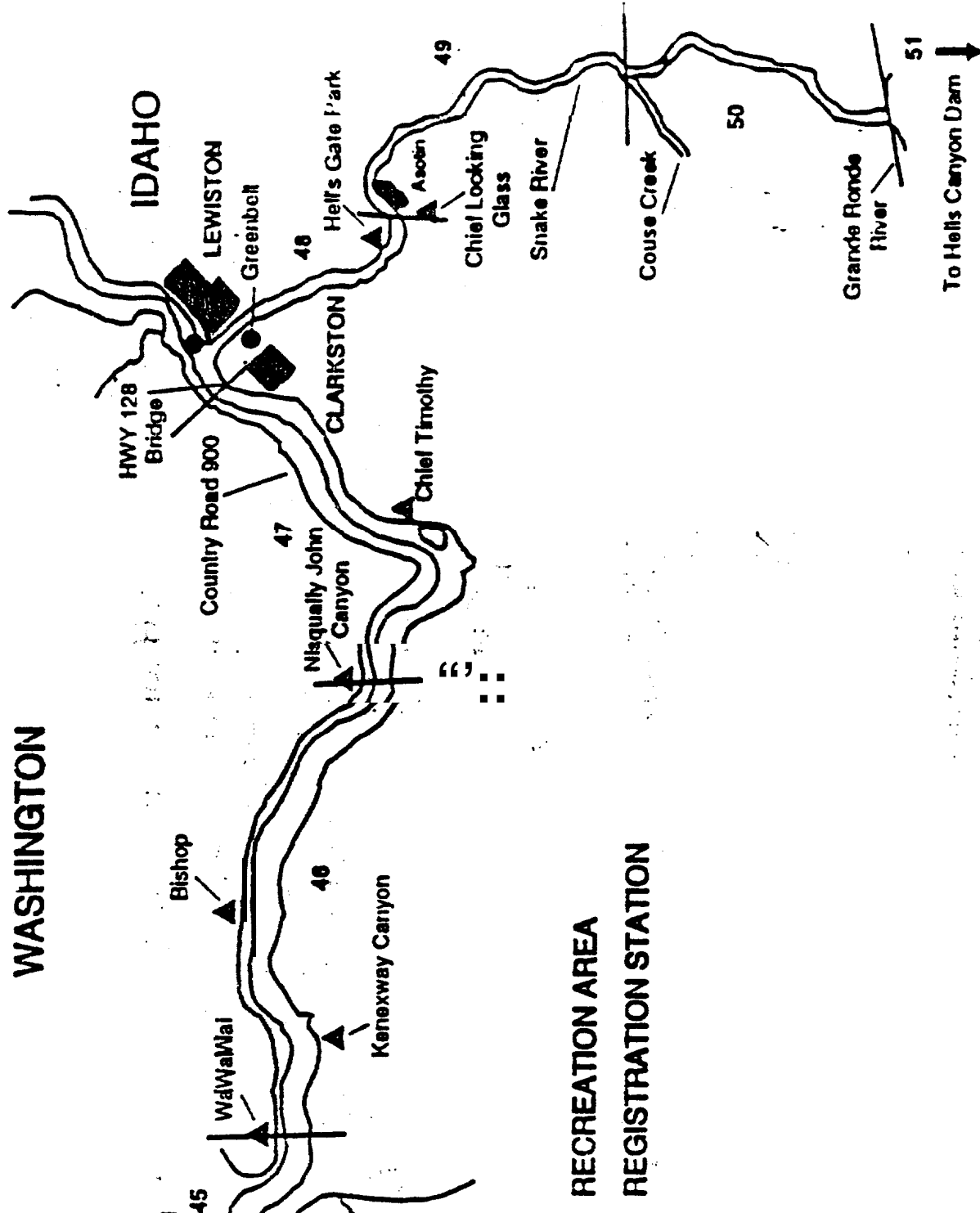


Appendix A-9. 1994 Northern **Squawfish** Sport-Reward Fishery fishing location codes, Lower Monumental Dam to Little Goose Dam.



44 Northern Squawfish Sport-Reward Fishery fishing location codes, Little Goose Dam to Lower Goose Dam.

WASHINGTON



RECREATION AREA

REGISTRATION STATION

4 Northern Squawfish Sport-Reward Fishery fishing location codes, Lower Granite Dam to Hell's Canyon Dam.

APPENDIX B

Fish Species Codes

Table B-1. Sport-Reward Fishery field species codes.

| | | | |
|--------------|--|------------|------------------------------------|
| LMB | Bass, Largemouth | LRS | Sucker, Largescale |
| RKB | Bass, Rock | LNS | Sucker, Longnose |
| SMB | Bass, Smallmouth | s | Sunfish, (Unknown) |
| BG | Bluegill | TNC | Tenth |
| BH | Bullhead (Unknown) | CT | Trout, cutthroat (Unknown) |
| YBH | Bullhead, Yellow | CCT | Trout, Cutthroat Coastal |
| BBH | Bullhead, Brown | SCT | Trout, Cutthroat Searun |
| BLB | Bullhead, Black | LCT | Trout, Cutthroat Lahontan |
| CP | Carp | DB | Trout, Dolly/Bull (Unknown) |
| BCF | Catfish, Blue | BLC | Trout, Bull (Char) |
| cc | Catfish, Channel | DVC | Trout, Dolly Varden (Char) |
| FCF | Catfish, Flathead | RB | Trout, Rainbow (Resident) |
| CMO | Chiselmouth | RU | Trout, Rainbow (Unknown) |
| CRC** | Columbia River Chub | TR | Trout, (Unknown) |
| c | Crappie (Unknown) | WAL | Walleye |
| BC | Crappie, Black | WM | Warmouth |
| Wc | Crappie, White | WF | Whitefish, Mountain |
| SF | Flounder, Starry | | |
| PMO | Peamouth | | |
| YP | Perch, Yellow | | |
| PS | Pumpkinseed | | |
| CK | Salmon, Chinook | | |
| CH | Salmon, Chum | | |
| co | Salmon, Coho | | |
| K | Salmon, Kokanee | | |
| SA | Salmon, Pacific (Unknown) | | |
| PK | Salmon, Pink | | |
| s o | Salmon, Sockeye | | |
| JCK* | Salmon, Chinook (Juvenile) | | |
| JCH* | Salmon, Chum (Juvenile) | | |
| JCO* | Salmon, Coho (Juvenile) | | |
| JPk* | Salmon, Pink (Juvenile) | | |
| JSO* | Salmon, Sockeye (Juvenile) | | |
| SAN | Sandroller | | |
| COT | Sculpin, (General) | | |
| AMs | Shad, American | | |
| RS | Shiner, Redside | | |
| NSF | Squawfish, Northern | | |
| SS | Steelhead, Summer | | |
| Sw | Steelhead, Winter | | |
| SH | Steelhead (Unknown) | | |
| JSA* | Steelhead, Juvenile (Adipose Absent) | | |
| JSP* | Steelhead, Juvenile (Adipose Present) | | |
| GRS | Sturgeon, Green | | |
| WS | Sturgeon, White | | |
| SK | Sucker (Unknown) | | |
| BRS | Sucker, Bridgelip | | |

* New codes for 1995

** Conventional naming for NSF Sport-Reward Program

APPENDIX C

Pay Voucher/Questionnaire

Methods

Registered anglers received a pay voucher/questionnaire each time they returned northern squawfish >11 inches in total length to a registration station. The angler's name, address and social security number were recorded on the front of the voucher along with the number of northern squawfish received for **payment**, the registration station number and the corresponding document number. Once the angler signed the voucher in the presence of the **technician**, the exit interview process was completed. The angler was required to complete a questionnaire (**Appendix** Figure 1-C), which was found on the back of the voucher, and send it to Pacific States Marine Fisheries Commission (**PSMFC**). **PSMFC** entered the information from the front of completed vouchers and returned incomplete vouchers to the angler for correction. Vouchers with technician errors were returned to Washington Department of **Fish** and Wildlife (**WDFW**) for verification of the number of **fish**, missing signatures and missing document numbers. **After** payment was issued, the voucher was returned to WDFW where **information** from the questionnaire was entered into a database.

Results and Discussion

Approximately 20% of the 13,046 vouchers received from PSMFC had incomplete or incorrect data. Anglers that returned vouchers with possible incorrect data were called by WDFW technicians and the data corrected when possible. Data that could not be reconciled was not included in our analysis. Part of the errors made by anglers were due to a misunderstood example given on the questionnaire concerning Questions 1, 2 and 3 (**Appendix** Figure 1-C). This example led anglers to believe they should record the same amount of fish in Question 1 as in Question 2 (**Appendix** Figure 1-C). Many anglers were unsure of what was being asked of them for Question 3, which asked anglers to **classify** which fish were caught while targeting northern **squawfish**. Since the voucher questionnaires were generally not completed in the presence of a **technician**, **confused** anglers could easily record incorrect target data. The accuracy of the data concerning fish caught while targeting northern squawfish may therefore be inaccurate.

The number of fish reported caught on a particular day sometimes differed between the exit and voucher data. To reconcile problems with the voucher and exit **data**, the two sets were combined and a low and high estimate was generated in the harvest evaluation section of this report (**Appendix** F). Voucher, exit and phone **survey** data were also compared in **Appendix** F to establish the 1995 returning angler sampling method.

Eighty-nine percent of **all** fish harvested were northern squawfish >11 inches (**Appendix** Table C-1), which shows the northern squawfish sport-reward fishery was **successful** in directing the majority of harvest to northern squawfish. A total of 28,673 northern **squawfish** under 11

inches were caught by returning anglers, but only 11,372 were harvested, which shows that most anglers return undersized northern **squawfish** to the water.

The top five fishes (other than northern squawfish) harvested by returning anglers were **smallmouth** bass (*Micropterus dolomieu*; 2,063); shad (*Alosa sapidissima*; 885); walleye (*Stizostedion vitreum*; 503); peamouth (*Mylocheilus caurinus*; 452); and channel catfish (*Ictalurus punctatus*; 263; Appendix Table C-1). The same fishes top the list of frequently harvested while targeting northern **squawfish** (Appendix Table C-2). Peamouth were probably harvested due to misidentification as northern **squawfish**, but the other fishes were known to be popular food fish. The list noticeably changed when considering fish caught, as opposed to fish harvested while targeting northern squawfish. **Smallmouth** bass (6,371), peamouth (2,014), white sturgeon (*Acipenser transmontanus*; 1,568), walleye (950) and suckers (*Catostomus* spp.; 911) were the most susceptible to being caught on popular northern squawfish baits (Appendix Table C-2).

Approximately 75% of all fish caught while targeting northern **squawfish** (excluding northern **squawfish**) were returned to the river. This high percent of fish returned to the river dramatically lowers the sport-reward fishery's impact on fishes other than northern squawfish (Appendix Table C-2).

The voucher data reported 396 adult **salmonids** caught while targeting northern squawfish (Appendix Table C-2). The accuracy of this data was questioned since anglers were **confused** by the voucher question regarding targeted fish. The actual number of adult **salmonids** caught while targeting northern squawfish was probably considerably less. Juvenile salmonid catch while targeting northern **squawfish** was also high (201 fish). The 1995 returning angler sampling method **will** correct these problems and provide more reliable estimates of catch while targeting northern squawfish.

Anglers were asked to record how they found out about the northern squawfish **sport-reward** fishery in Question 4 (Appendix Figure 1-C). Word of mouth (7,890) was the most frequently cited way that anglers discovered the sport-reward fishery, followed by newspaper (3,785), radio (215), television (193) and club activity (100). Refer to Appendix D for **further** discussion of promotional activities.

Question 5 (Appendix Figure 1-C) showed that 74% of returning anglers would not have taken their fishing trip if the sport-reward fishery had not existed. The same question was posed to non-returning anglers and showed only **28%**. This discrepancy showed **further differences** between returning and non-returning anglers.

The majority of participating anglers were from Washington (**52.7%**) and Oregon (41.3%). The remaining anglers resided in Idaho and other states. **Since** the majority of northern squawfish sport-reward fishery waters bordered Washington and **Oregon**, **participation** was expected to be highest from these two states.

Question 7 addressed the possibility of conducting the sport-reward **fishery** in certain areas by offering anglers a higher reward (\$20-\$5,000) per fish for tagged northern **squawfish** only. Results indicated that **76%** (9,993) of anglers would have decreased their participation by using this new system. Six percent (785) of anglers indicated their participation would increase, 17% (2,265) of anglers would not change their participation% and. 1 1% listed angler response as unknown. A sport-reward fishery based on paying only for tagged northern squawfish was not recommended.

Both voucher and questionnaire must be completed before payment will be made. An incomplete voucher or questionnaire will be returned to sender for completion. This will delay processing and payment.

PLEASE CIRCLE OR FILL IN THE APPROPRIATE ANSWER

1. Please list the number of fish caught
that you kept in the boxes:

| | |
|---------------------------|----------------------|
| Squawfish over 11 inches | <input type="text"/> |
| Squawfish under 11 inches | <input type="text"/> |
| Other (specify) | <input type="text"/> |
| <input type="text"/> | <input type="text"/> |
| <input type="text"/> | <input type="text"/> |
| <input type="text"/> | <input type="text"/> |

2. Please list the number of fish you caught
that you released unharmed in the boxes.

| | |
|---------------------------|----------------------|
| Squawfish over 11 inches | <input type="text"/> |
| Squawfish under 11 inches | <input type="text"/> |
| Other (specify) | <input type="text"/> |
| <input type="text"/> | <input type="text"/> |
| <input type="text"/> | <input type="text"/> |
| <input type="text"/> | <input type="text"/> |

3. Please indicate for each type& size
of fish whether you caught them
while targeting Northern Squawfish.

| | |
|---|---|
| Y | N |
| Y | N |
| Y | N |
| Y | N |
| Y | N |
| Y | N |

EXAMPLE:

| | |
|---------------------------|---------------------------------|
| Squawfish over 11 inches | <input type="text" value="2"/> |
| Squawfish under 11 inches | <input type="text" value="10"/> |
| Other (specify) | <input type="text"/> |
| Smallmouth Bass | <input type="text" value="4"/> |

| | |
|---------------------------|---------------------------------|
| Squawfish over 11 inches | <input type="text" value="2"/> |
| Squawfish under 11 inches | <input type="text" value="10"/> |
| Other (specify) | <input type="text"/> |
| Smallmouth Bass | <input type="text" value="6"/> |

| | |
|------------------------------------|------------------------------------|
| <input checked="" type="radio"/> Y | <input type="radio"/> N |
| <input type="radio"/> Y | <input checked="" type="radio"/> N |
| <input checked="" type="radio"/> Y | <input type="radio"/> N |

4. How did you find out about
the Northern Squawfish
Sport-Reward Fishery?
A. Newspaper
B. Radio
C. T.V.
D. Word Of Mouth
E. Club Activity
F. Other (specify)

5. Would you have taken this fishing trip if
the Sport-Reward Fishery did not exist?
A. No
B. Yes
6. State of Residence:
A. Washington
B. Oregon
C. Idaho
D. Other (specify)

7. If the Northern Squawfish Sport-Reward Fishery were to
change the current reward system, which pays \$3 per
northern squawfish greater than 11", to anew system
that paid \$20-\$5,(X)0, for only northern squawfish that
were tagged, would this affect you participation?
A. The new system would increase my participation.
B. The new system would decrease my participation,
C. The new system would not affect my participation.

Figure 1-C. Northern Squawfish Sport-Reward Fishery pay voucher questionnaire, 1994.

c-1. The number of fish recorded from voucher data as harvested or released for each species. All fish were included regardless of which species the angler targeted.

| Species | Harvested | Released |
|-----------------------------|-----------|----------|
| American shad | 885 | 508 |
| Brown bullhead | -- | |
| Black crappie | -- | : |
| Bluegill | 28 | 56 |
| Bullhead (general) | 92 | 251 |
| Bull trout | -- | 1 |
| Bridgelip sucker | -- | 2 |
| Crappie (general) | 9 | 32 |
| Channel catfish | 267 | 187 |
| Chum salmon | 1 | -- |
| Chinook salmon | 1 | 15 |
| Chiselmouth | 5 | 43 |
| Coho salmon | -- | 2 |
| Carp | 37 | 190 |
| Crayfish | -- | 5 |
| Cutthroat (general) | -- | 3 |
| Green sturgeon | 1 | -- |
| Juvenile salmonid (general) | 16 | 212 |
| Largemouth bass | 26 | 49 |
| Northern squawfish (>11) | 126778 | 275 |
| Northern squawfish (<11) | 11372 | 17301 |
| Peamouth | 452 | 1695 |
| Redside shiner | 6 | -- |
| Rainbow trout (unknown) | 79 | 206 |
| Sunfish | 2 | 51 |
| Salmon (general) | 8 | 71 |
| Searun cutthroat | 2 | -- |
| Sculpin (general) | 13 | 214 |
| Smallmouth Bass | 2063 | 6862 |
| Starry flounder | 49 | 550 |
| Steelhead (unknown) | 65 | 56 |
| Sucker | 154 | 845 |
| Trout (unknown) | 1 | -- |
| Torrent Sculpin | -- | 1 |
| Walleye | 503 | 954 |
| Whitefish | 26 | 30 |
| White sturgeon | 75 | 1950 |
| Yellow bullhead | 1 | 1 |
| Yellow perch | 203 | 170 |
| TOTALS | 143220 | 32794 |

Table C-2. The number of fish recorded **from** voucher data as caught or harvested for each species **while** targeting northern squawfish.

| Species | Caught | Harvested |
|-----------------------------|--------|-----------|
| American shad | 437 | 410 |
| Brown bullhead | 2 | 0 |
| Bluegill | 61 | 28 |
| Bullhead (general) | 285 | 65 |
| Bull trout | 1 | 0 |
| Bridgelip sucker | 1 | 0 |
| Crappie (general) | 38 | 8 |
| Channel catfish | 367 | 189 |
| Chum salmon | 1 | 1 |
| Chinook salmon | 15 | 1 |
| Chiselmouth | 46 | 4 |
| Coho salmon | 2 | 0 |
| Carp | 201 | 33 |
| Crayfish | 5 | 0 |
| Cutthroat (general) | 1 | 0 |
| Green sturgeon | 1 | 1 |
| Juvenile salmonid (general) | 201 | 12 |
| Largemouth bass | 48 | 19 |
| Northern squawfish (>11) | 118560 | 118292 |
| Northern squawfish (<11) | 23786 | 9027 |
| Peamouth | 2014 | 390 |
| Rainbow trout (unknown) | 234 | 66 |
| Sunfish | 51 | 1 |
| Salmon (general) | 62 | 8 |
| Searun cutthroat | 2 | 2 |
| Sculpin (general) | 195 | 8 |
| Smallmouth Bass | 6371 | 1590 |
| Starry flounder | 563 | 43 |
| Steelhead (unknown) | 77 | 42 |
| Sucker | 911 | 109 |
| Trout (unknown) | 1 | 1 |
| Torrent Sculpin | 1 | 0 |
| Walleye | 950 | 317 |
| Whitefish | 56 | 26 |
| White sturgeon | 1568 | 59 |
| Yellow perch | 265 | 119 |

APPENDIX D

Promotional Activities

Introduction

In 1994, the Bonneville Power Administration (**BPA**) increased its emphasis on advertising and promotional activities for the northern squawfish sport-reward fishery over that of previous years. Attempts to increase harvest were based on increasing angler effort. The goal of the incentive and advertising program for the 1994 sport-reward fishery was to increase the number of angler days spent by participants to 100,000. Prior to 1994, the highest number of angler days spent during the northern **squawfish** sport-reward fishery season was 88,000 in 1992.

To achieve that goal, several promotional activities and advertising options were implemented during the 1994 northern **squawfish** sport-reward fishery, which operated from May 2 through September 25. These included **BPA-sponsored** tournaments, weekly tournaments, \$50 tagged northern **squawfish**, random drawings, and the use of advertising through newspaper and radio and by distributing printed materials.

Methods

Harvest and effort totals associated with promotional activities were monitored during the season on a weekly basis, and evaluated **after** the season to determine if the results produced positive contributions to the 1994 northern **squawfish** sport-reward fishery. Positive results were based on the ability of the incentive activity to generate increased effort or harvest for the northern squawfish sport-reward fishery.

Evaluation data for promotional programs were gathered using two methods. A question on the pay voucher asked returning anglers how they heard about the northern **squawfish sport-reward** fishery. Non-returning anglers were asked via telephone survey how the different promotional programs **affected** their participation. Based on these results, plans could be made for designing and implementing promotional activities for 1995.

Reward

The 1994 northern **squawfish** sport-reward fishery offered recreational anglers a \$3 reward for each northern squawfish with a total length of 11 inches or longer that was turned into one of the sport-reward fishery's 14 registration stations.

BPA Tournaments

BPA sponsored two groups of northern squawfish tournaments during the 1994 season. The lower Columbia River group consisted of Tournament I (**T1**), which included Sites 1-6, and Tournament II (**T2**), which included Sites 7-9. The upper Columbia River group consisted of Tournament III (**T3**), which included Sites 10-13 and Tournament IV (**T4**), which included only Site 14. **T1** and **T2** were conducted concurrently in the time period from July 9-16, while **T3** and **T4** took place during the July 16-24 time period.

BPA's advertising agency (Cole and **Webber**) solicited retail merchants of sporting goods to become co-sponsors of these tournaments. The **G.I. Joe's** retail chain was signed as a co-sponsor for **T1** and **T2**. They contributed \$5,000 in **gift** certificates and BPA added \$4,000 cash for a total of \$9,000 for **T1** and **T2**.

For each tournament, prizes were awarded to anglers returning the longest three northern squawfish in each of four age categories (for their tournament area). These categories included 12 years and under, 13-17 years, 18-54 years and 55 and over.

A co-sponsor was not found for **T3** and **T4** so BPA acted as the sole sponsor and offered \$4,000 to be evenly split between the two tournaments. Tournament rules and age categories for winners were the same as for **T1** and **T2**, although the prize amounts were lower since there was no co-sponsor.

Tournaments were evaluated by monitoring harvest and effort levels during tournament weeks at each registration station. Tournament week results were compared to results from the prior week in 1994 as well as from the same week in 1993 to determine what impact, if any, this activity had on the northern squawfish sport-reward fishery.

Weekly Tournaments

In August, **WDFW** proposed that a weekly tournament be implemented by BPA at all 14 sites as a way to boost effort and harvest. The "end-of-season" weekly tournament was designed to entice anglers who had regularly participated in the **fishery** earlier in the **season**, back to the northern squawfish sport-reward fishery. The tournament began on August 8 at **all** 14 sites for a four-week trial period with the option to extend it an additional week if harvest levels remained high. Cash prizes were awarded for the three longest northern **squawfish** turned in to each site over the course of each week. Each week a total of \$3,500 was divided into \$250 per site. Cash prizes were \$125 for first, \$75 for second and \$50 for third.

Independent Tournaments

There were three independent tournaments held during the 1994 season. Independent tournaments are characterized as being **non-BPA** sponsored events that are planned, organized and promoted entirely by the sponsoring organization with a varying level of guidance from **WDFW**.

The **Wahkiakum** Conservation District held its Second Annual **Squawfish** Tournament from May 28-July 4 at the **Cathlamet** and **Kalama** registration stations. The tournament was open to the public for a \$6 entry fee that was collected by local retailers involved in the tournament. Tournament organizers made two changes to their tournament (from 1993) in hopes of encouraging more participation in 1994. The entry **fee** was set at lower level than in 1993, and the **Kalama** station was added as an eligible site. Prizes were awarded by the **Wahkiakum** Conservation District to anglers with the longest northern **squawfish** turned in over the course of the tournament.

The Lower Columbia Walleye Club held a “squawfish roundup” in conjunction with their walleye tournament on July 9 and 10 at the Gleason station. Entry **fees** were \$100 per **two-**person team or \$25 per amateur. There were no prizes for northern**squawfish**, however tournament organizers made arrangements with WDFW so that all tournament entrants were registered with the northern squawfish sport-reward fishery so that the reward from any northern squawfish caught during the walleye tournament were donated to a local non-profit group for kids.

The **Ridgefield** Marina Tenants Association included northern squawfish in their July 4 fishing tournament at the **Ridgefield** Marina. The tournament operated from 12 p.m. until 4 p.m. and was open to the public. There was no registration station at this site so tournament organizers made arrangements with WDFW to operate a **satellite** registration station at the marina for the four hours of the tournament. Prizes were awarded to the angler catching the hugest or the most fish of any **species**; there were also prizes for the largest and the most northern **squawfish**.

Tagged Northern Squawfish

During the 1994 **season**, an additional **monetary** reward of \$50 was offered for select tagged northern **squawfish** that were turned in to registration stations. Eligible tags were**from** work done by ODFW for northern squawfish exploitation estimates for the Northern Squawfish Management Program. To collect the \$50 reward, anglers were required to turn in tagged northern squawfish with the tag still attached to the fish. WDFW technicians removed the **tag**, recorded data and issued the angler a separate tag voucher for their \$50 reward. Anglers submitted the tag and tag voucher to ODFW for verification and verified vouchers were sent to **PSMFC** for payment.

Random Drawings

Successful anglers were also eligible for random drawings on a monthly and year-end basis. **PSMFC** held five random drawings each month, including one overall drawing for \$1,000 and four regional drawings for \$250 each. Each **month**, winners were selected from a list of anglers who had been issued payment checks by **PSMFC** during the previous month. Anglers received one chance in the drawing for each northern squawfish paid. Regions included the same sites as for the EPA tournaments. There was one end-of-season drawing for \$5,000 that was open to all anglers who had been paid for northern **squawfish** before October 16, 1994.

Tagged Northern Squawfish Drawings

During 1994, PSMFC publicly held two random drawings of \$5,000 each. A midseason drawing was held July 11 and included anglers who were paid for tagged northern **squawfish** up to July 8. An end-of-season drawing included anglers paid for tagged northern **squawfish** from July 9 through October 10, 1994. **Anglers** received one chance per tagged northern **squawfish** and multiple entries were used for those anglers who had turned in multiple tagged northern **squawfish**.

Season Extension

In August, harvest levels for the northern **squawfish** sport-reward fishery were rising and the overall **CPUE** was higher than any previous years at this time. **WDFW** proposed that the northern squawfish sport-reward fishery and the end-of-season weekly tournament be extended an additional two weeks. The recommendation was made to extend the season on a **trial** basis at six selected registration stations that were harvesting significant numbers of northern **squawfish** and where it was believed that anglers could maintain these harvest levels. **WDFW** checked with other members of the Northern **Squawfish** Management Program to **verify** that additional costs associated with extending the season were able to be absorbed within current budget levels and obtained approval for the extension on September 6.

Advertising

The advertising portion of the 1994 promotional program consisted of paid advertisements in newspapers and magazines, news releases and written articles, printed materials, and paid radio advertising. The voucher questionnaire asked **successful** anglers where they had heard about the northern squawfish sport-reward fishery. Results from the voucher were compiled to assist in determining the priority for 1995 advertising activities.

Advertisements for newspapers and magazines were used from early June to mid-August. These advertisements included graphics with text about the northern **squawfish** sport-reward fishery and generally targeted novice anglers from population centers located near registration stations. Advertisement size was usually one-fourth page and appeared once per week in daily newspapers and once per month in magazines.

News releases originated with BPA as **information** became available and were intended to generate written articles or **television/radio** coverage about the northern **squawfish** sport-reward fishery. Topics included general program **information** and rule changes, updated harvest and effort totals, and tournament and random drawing winners.

BPA produced several types of printed items to advertise or provide information about the sport-reward fishery such as pamphlets and posters.

The "Catch a Killer, Save a Salmon" pamphlet explained the guidelines of the northern squawfish sport-reward fishery and how to participate. A "How to Catch Them" pamphlet

covered tackle and techniques for catching northern **squawfish** and a one page insert explained the various incentive activities that were offered in 1994. Program personnel distributed and maintained supplies of these printed materials at retail businesses, bait and tackle shops, and information outlets where the public had access to them.

Informational packets called “Northern Squawfish Starter Kits” were designed to provide novice anglers with all the information that they would need to participate in the fishery. The kit was contained in an envelope with squawfish graphics; contents included BPA squawfish pamphlets, the incentive activities insert, maps with directions to registration stations and a lure for catching **squawfish** (a lead-head jig with plastic grub). The **free** kits were available at retail outlets belonging to the co-sponsor of the BPA tournaments or by calling BPA.

A 60-second radio spot was produced to promote the BPA sponsored tournaments, the northern squawfish sport-reward fishery and the availability of the free starter kits. The radio spot was run for a three-week period on multiple stations in the Portland/Vancouver, The **Dalles/Hood** River, **Tri-Cities**, and **Lewiston/Clarkston** markets. Coverage began two weeks prior to the BPA tournaments start date and ran until the end of tournament week for each area.

800 Hotline

The northern **squawfish** sport-reward fishery operated a toll-free hotline for anglers to use as a source of information about the program. The **information** on the hotline was accessed using touch-tone phones to select various menu topics. Information provided by the hotline included updated weekly harvest totals, program guidelines, voucher **information**, incentive information and “how to catch them” **information**. Rotary callers were forwarded to a customer service **specialist** for assistance.

Results/Discussion

Rewards

The 1994 northern **squawfish** sport-reward fishery generated 40,783 angler days and collected 129,434 northern squawfish over 11 inches. For the sport-reward fishery to increase harvest, it must increase angler effort, especially from experienced anglers. This maybe accomplished by targeting top anglers from previous seasons and providing them with incentives to fish longer and/or harder, and by recruiting new anglers into the fishery.

Money was the prime motivator for 40% of anglers participating in the northern **squawfish** sport-reward fishery and at **least** somewhat important to **77%**, according to results from the 1993 phone survey (**Klaybor** et al. 1995). Effort jumped 178% when the reward for northern squawfish was increased from \$1 to \$3 in 1990; effort after the reward increase generally remained above that of the early season (**Vigg** et al. 1990). Harvest during the **first** week of the \$3 reward (in 1990) increased 20 times the level of the prior week and also **generally** remained above earlier

levels. Based on this **data**, the best way for the northern **squawfish** sport-reward fishery to have a large impact on harvest and effort in 1995 is to increase the reward level.

BPA Tournament

Phone survey data indicated that tournaments increased participation in the northern squawfish sport-reward fishery for 43°A of surveyed anglers (**Appendix** Figure 1-D). During periods of **BPA-sponsored** tournaments, overall effort for the northern squawfish sport-reward fishery increased by 8% over the period immediately preceding BPA tournaments (**Appendix** Figures 2-D and 3-D). Effort increased 4% for the lower Columbia River group of tournaments and 19°/0 for the upper **Columbia** River group of tournaments.

Effort increased at three of the four tournaments from the **preceding** time period. **T1** sites showed an increase in effort of **10%**. Four of the six sites showed increases ranging from 10% to **50%**. **T2** was the least successful with **all** three sites, showing decreases in effort ranging from 2% to 31%. **T3** showed an overall increase in effort of 4% with increases at three of four sites ranging from 9°/0 at Site 13 to 25°/0 at Site 11. **T4** was the most **successful** tournament **from** an effort standpoint with a 70°/0 increase seen over the previous period.

While overall effort increased during BPA tournament periods, harvest declined 26% for the northern squawfish sport-reward fishery with eight of the 14 sites showing declines, and one site remaining the same (**Appendix** Figures 2-D and 3-D).

Harvest declined 66% for the lower Columbia River group of tournaments when compared with the **time** period prior to the tournament. **Harvest** increased 9°/0 for the upper Columbia River group of tournaments from the prior period.

The overall decline in harvest for the sport-reward fishery was supported by the results of the individual tournaments where three of four showed declines in harvest from the prior period. **Harvest** declined 62% overall at **T1** sites. Declines were seen at four of six sites and ranged from 31% at Site 6 to 77% at Site 2. One site stayed the same. **Harvest** declined **22%** overall at **T2** sites where all three sites showed declines ranging from 2°/0 at Site 9 to 66°/0 at Site 7. **T3** was the only tournament in which harvest clearly increased (**10%** overall) over the preceding period. **Harvest** increased at three of four sites ranging from 21% at Site 13 to 56°% at Site 10. **T4** harvest increased by 5°/0 over the **preceding** period.

The BPA tournaments appear to be successful at increasing overall effort in the northern squawfish sport-reward **fishery**, but the results do not indicate an increase in harvest. This maybe due to the fact that the northern squawfish sport-reward fishery traditionally experiences **declining** harvest around this time of year. It is also possible that tournaments attract new anglers to the fishery who do not have the knowledge or experience to harvest large numbers of northern squawfish. **T3** was the most **successful** of the four tournaments since both effort and harvest showed increases over the period prior to the tournament. **T1** and **T4** showed potential by being able to draw anglers from nearby population centers into the fishery. If the tournament is held earlier in the year in 1995, and if participants are trained to have better success at **harvesting**

northern **squawfish**, then this activity may be able to generate increased northern **squawfish** harvest as well.

Weekly Tournaments

The first week of the “end-of-season” weekly tournament produced higher effort than the prior week at eight of the 14 registration stations (Appendix Figure 4-D). Harvest during that **first** week increased at seven of the 14 sites over the prior week.

As in previous seasons, effort and harvest levels began to decline by mid-July. Many regular anglers had already stopped participating for the season because they were unwilling to expend the increased effort required to catch “worthwhile” numbers of northern squawfish. The End-of-season tournaments **successfully** demonstrated that weekly tournaments can have positive results by bringing anglers back to the northern squawfish sport-reward fishery, even during traditionally slow times of year.

Independent Tournaments

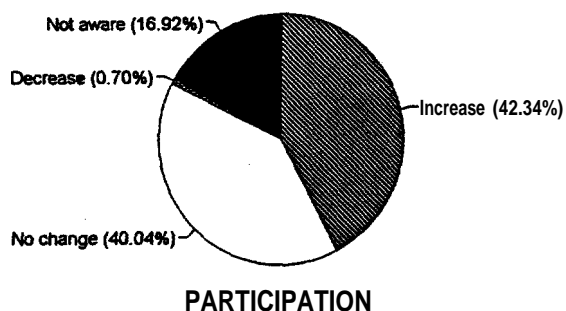
The **Wahkiakum** Conservation District reported that its tournament attracted 30 anglers who harvested 634 northern **squawfish** in 1994. The number of tournament entrants increased 76% from that of the year before when the district reported that 17 anglers harvested 70 northern squawfish.

Participation for the Lower Columbia Walleye Club tournament produced 34% (65 anglers) of the Gleason site’s total angler days and contributed 14%(18 northern **squawfish**) of the harvest at the Gleason site for the two-day tournament.

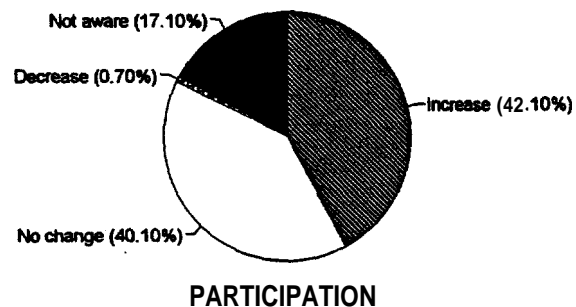
The **Ridgefield** Marina Tenants Association tournament harvested 40 northern **squawfish** that were under 11 inches long and only four that were eligible for the \$3 reward. These northern squawfish were **harvested** by 42 anglers.

Small tournaments such as these offer the northern **squawfish** sport-reward fishery an inexpensive way to generate interest and excitement (in addition to effort and harvest) in a manner that is independent of the planned BPA tournaments. **With** additional guidance from WDFW, the sport-reward fishery may be able to translate the effort from this type of tournament into significant additional northern **squawfish** harvest.

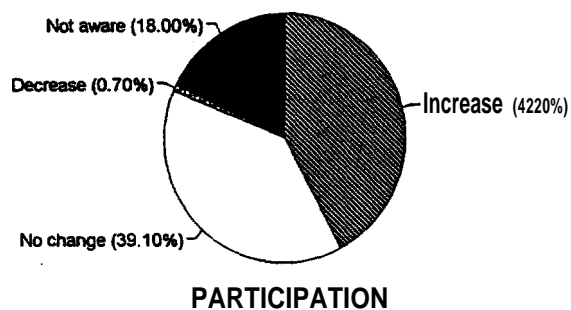
Response to \$50 tagged fish reward



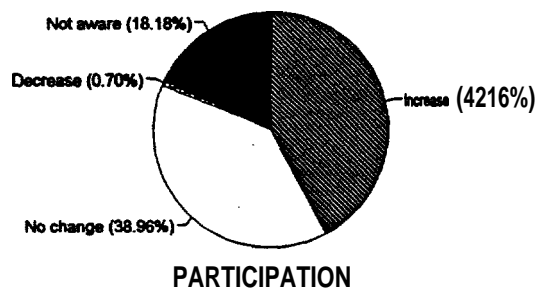
Response to \$5,000 tag fish drawing



Response to \$250 monthly draw-rig



Response to \$1,000 monthly drawing



Response to tournaments

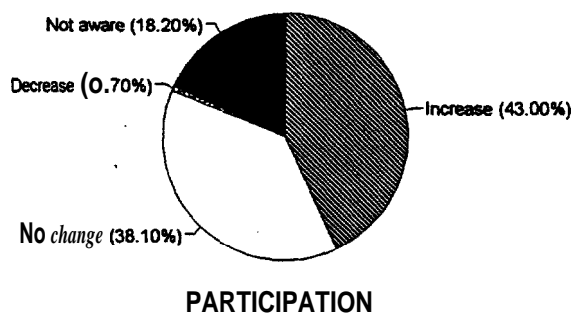


Figure 1-D. Angler responses to telephone survey question regarding how promotional activities affect participation.

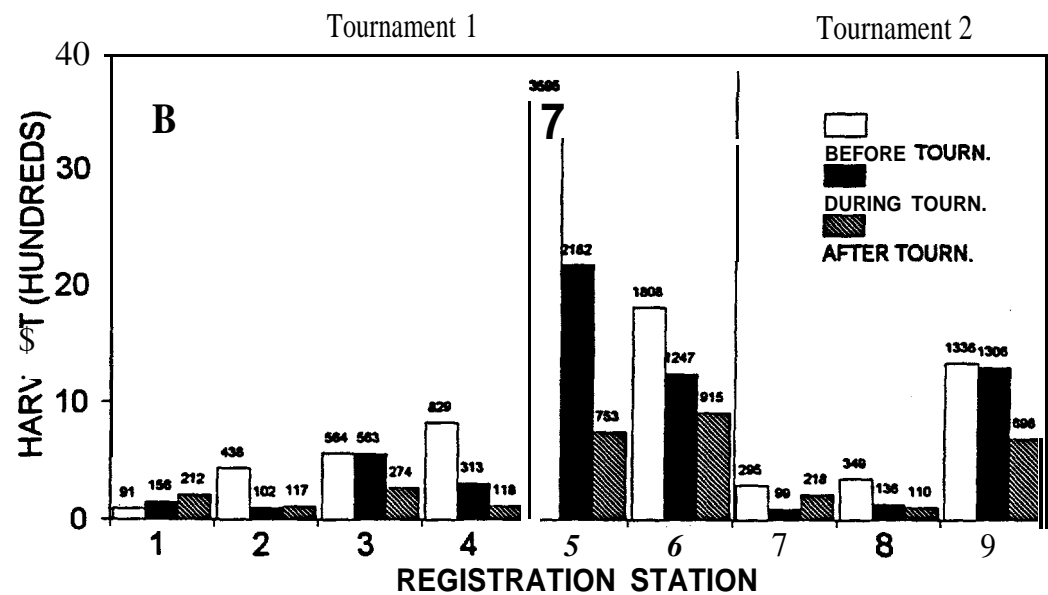
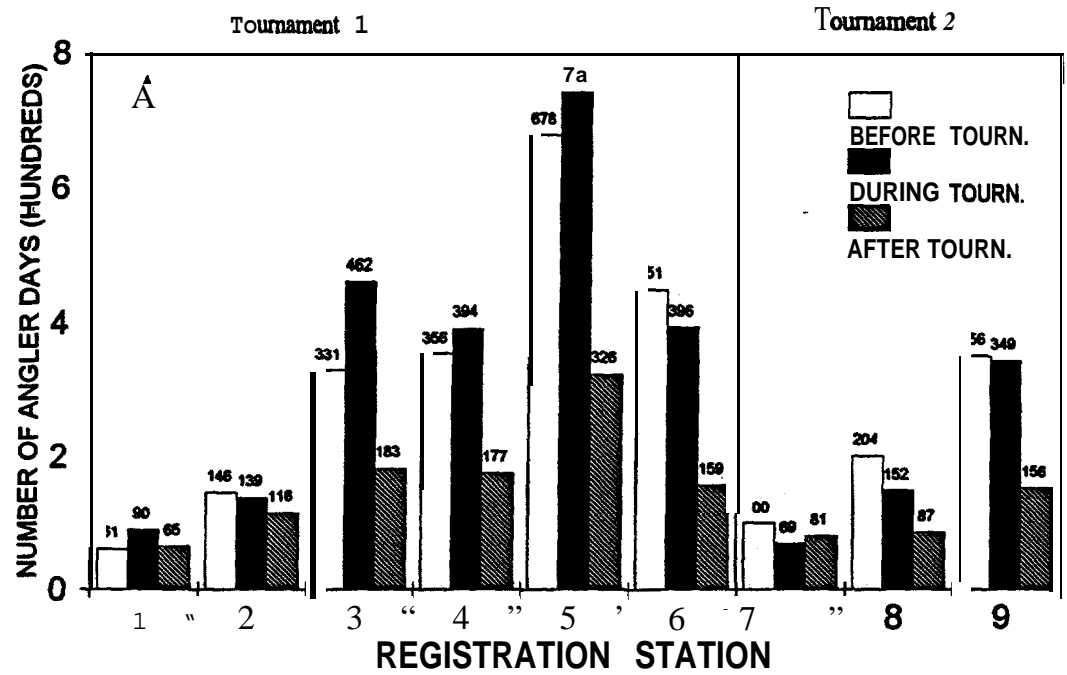


Figure 2-D. Angler effort and harvest for the Lower Columbia River during BPA tournaments.

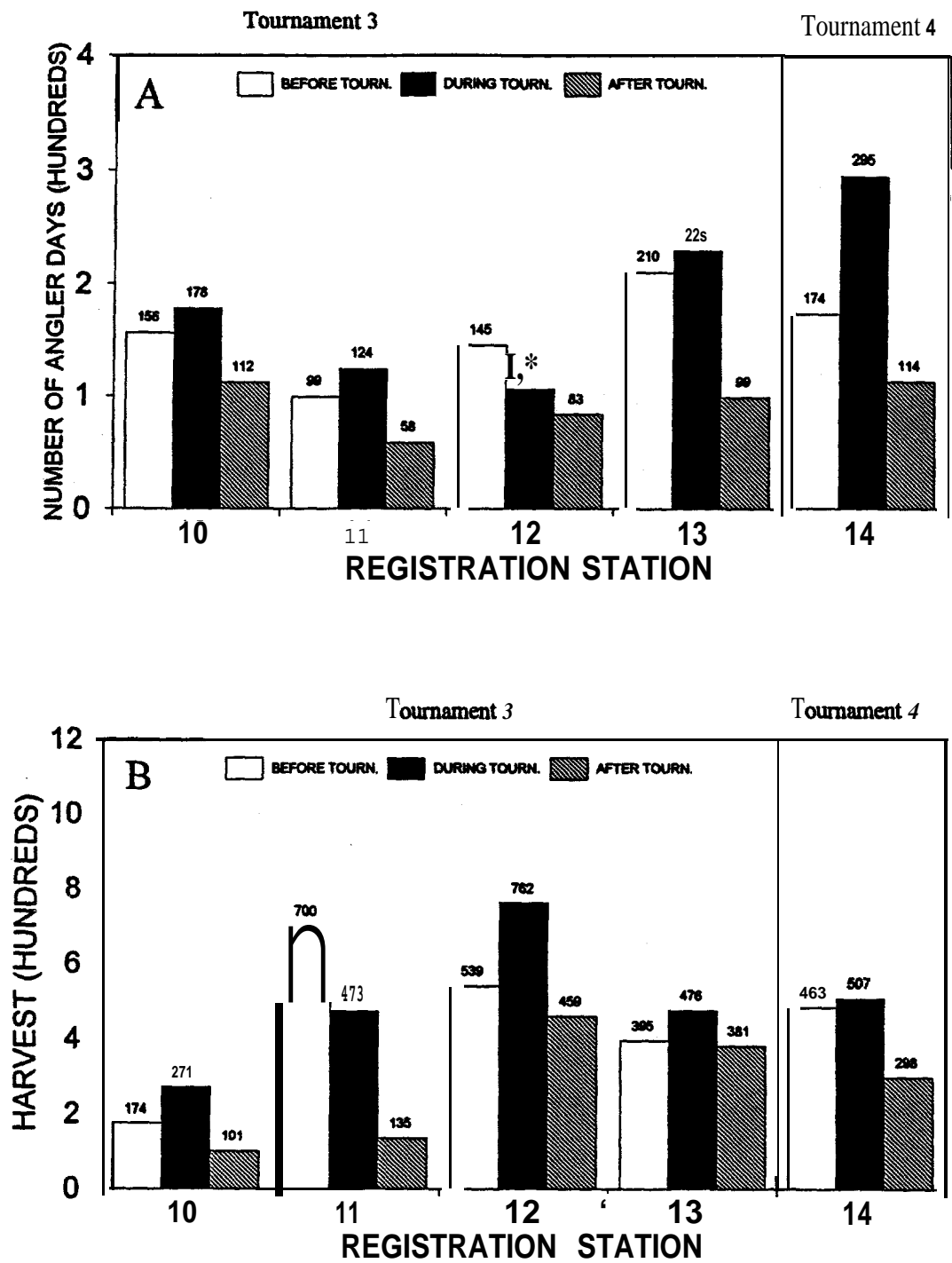


Figure 3-D. Angler effort and harvest for the Upper Columbia River during BPA tournaments.

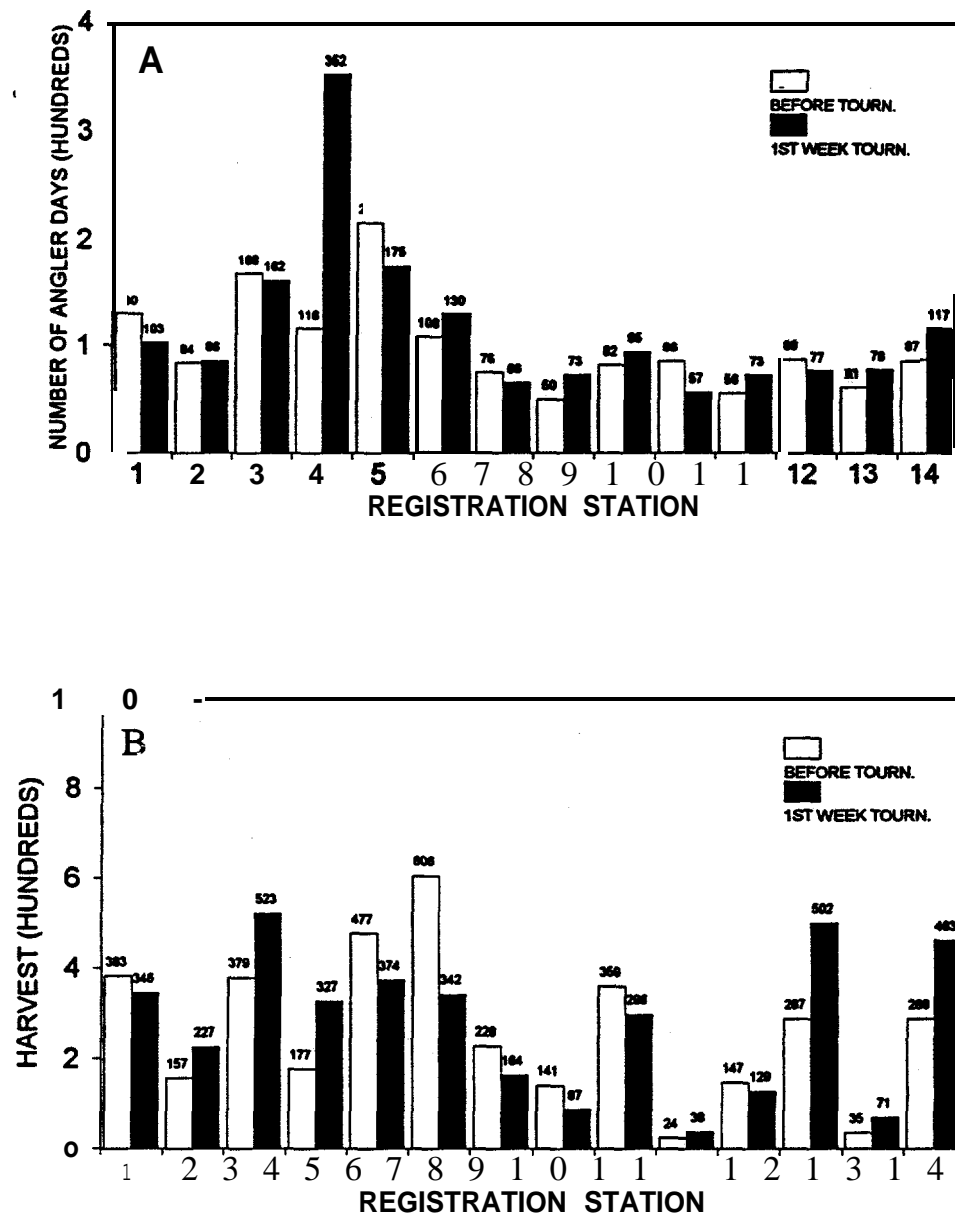


Figure 4-D. Angler effort and harvest for the first week of weekly tournaments versus prior week.

Tagged Northern Squawfish

Phone survey data showed that 42.3% of anglers indicated that “tagged northern squawfish” would increase their participation in the northern squawfish sport-reward fishery (Appendix Figure 1-D). Anglers returned 381 tagged northern squawfish in 1994, of which the majority were spaghetti tags. The \$50 reward was paid to 293 of these tags. Tags that did not qualify were often from radio tagged northern squawfish or from northern squawfish studies that were from areas outside the northern squawfish sport-reward fishery's boundaries.

Anglers harvesting tagged northern squawfish were spread out fairly evenly with most tags coming from areas with the highest effort, such as Portland/Vancouver. The most tags turned in by a single angler was six. Of the 14 registration stations in 1994, Site 5 processed the largest number of qualifying tags with 74 while Site 7 had the fewest tags turned in with only five (Appendix Figure 5-D). Most tagged squawfish were caught in May and June. The area below Bonneville Dam produced the most tagged northern squawfish of the nine reservoirs with 218. According to PSMFC, there were 185 different anglers involved in this promotion.

WDFW technicians reported that anglers indicated that the large number and wide distribution of tagged northern squawfish in the river made them feel that the \$50 prizes were attainable and that this promotion increased their interest in the northern squawfish sport-reward fishery. Since eligible tags for this promotion came from northern squawfish studies that were conducted within the sport-reward fishery's boundaries, this incentive encouraged anglers to fish within program boundaries. The \$50 reward may have also encouraged anglers to turn in tags from their fish.

Random Drawings

Phone survey data showed that 42.2% of anglers indicated that “random drawings” would increase their participation in the nonhero squawfish sport-reward fishery (Appendix Figure 1-D). Of the 26 winners of random drawings over the course of the 1994 season, winners were evenly spread out within the sport-reward fishery's geographical area.

Anglers generally indicated to WDFW technicians that this incentive did not directly affect their participation in the fishery since most felt that they didn't have a good chance of winning. They would prefer to have more smaller drawings that would reward larger numbers of winners.

Tagged Northern Squawfish Drawings

Phone survey data showed that 42.1% of anglers indicated that “tagged northern squawfish drawings” would increase their participation in the northern squawfish sport-reward fishery (Appendix Figure 1-D). Overall, there were 293 tags that were eligible for the two drawings. According to PSMFC, the midseason drawing included 170 entries from 121 people and the end-of-season drawing had 123 entries from 85 people. The most tags turned in by one person for either drawing was six. The public attendance for each drawing was 12-15 people.

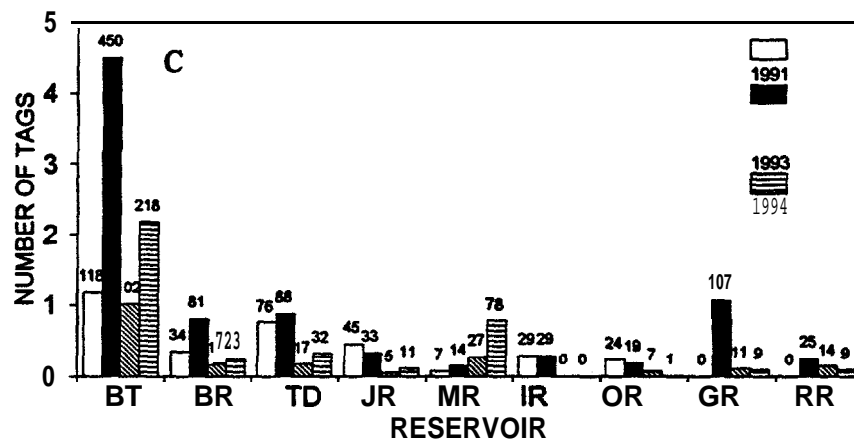
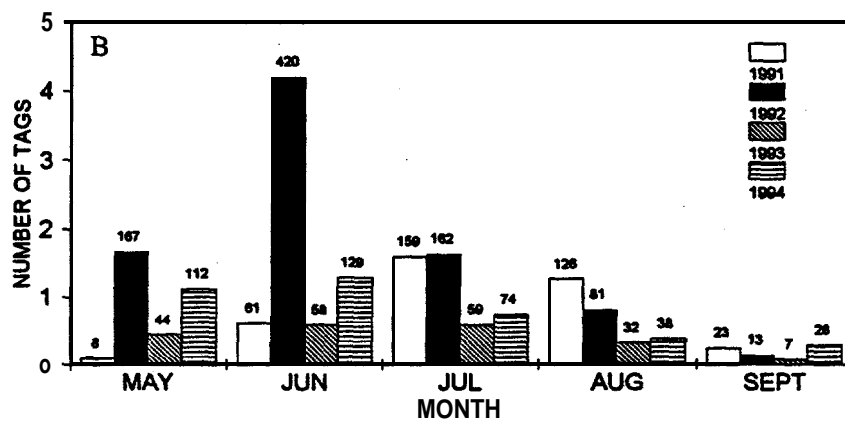
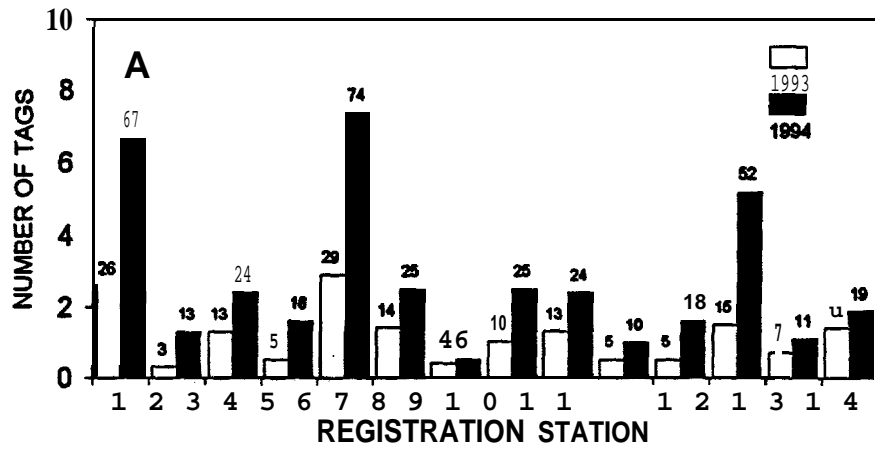


Figure 5-D. Tag recoveries by **registration** station during 1993 and 1994. Tag recoveries by month and reservoir during 1991-1994.

There was one eastern Washington winner and one western Washington winner for the two \$5,000 drawings. Angler comments to technicians regarding this incentive were similar to those for the monthly random drawings. They would prefer to have more winners even if it meant smaller reward amounts.

Season Extension

The two-week extension of the sport-reward **fishery** was responsible for generating 1,450 additional angler days, adding 9,349 northern **squawfish** to the yearly totals, and providing 32 additional winners for the end-of-season weekly tournament. The six sites that were selected for extension were able to maintain higher harvest and CPUE **levels** than the entire sport-reward fishery had for September in any previous year.

The results of the additional two-week season indicate that extending the northern squawfish sport-reward fishery on a selective basis can have a positive effect on the fishery's overall results. While the conditions that allowed these results in 1994 are not present every year, and extending all sites may not make sense, the sport-reward fishery should plan on keeping the end date for the fishery somewhat flexible to take advantage of high harvest and **CPUE**.

Advertising

Voucher data indicated that 26% of anglers questioned learned of the northern squawfish sport-reward fishery from the newspaper. This was the most-indicated category behind "word of mouth" at 63% (Appendix Figure 3-C). There were 76 insertions in 10 daily newspapers within the program area. There were also a total of 10 insertions in weekly or monthly publications. While newspaper advertising may not influence and inform the majority of anglers, it is still an important medium for reaching a significant number of them.

Ten news releases about various aspects of the northern **squawfish** sport-reward **fishery** were produced over the course of the season and generated at **least** an equal number of articles in newspapers during the **season**, although the exact number is not available. An additional way to encourage articles about the northern squawfish sport-reward fishery in 1995 is to pro-actively provide program information to outdoor writers via a mailer prior to the start of the season.

BPA printed 50,000 "Catch a Killer," and 50,000 "How to Catch Them" pamphlets. WDFW technicians distributed approximately 30,000 of each to the public through our sites and to over 156 different retail outlets in Washington, Oregon and Idaho. A **small** number of posters were also distributed to outlets that received pamphlets.

There were over 3,800 "**Northern** Squawfish Starter Kits" given out during the 1994 season. Three thousand were distributed through the co-sponsor of BPA's lower Columbia River tournaments. BPA mailed the remaining kits to anglers per telephone request.

The number of northern **squawfish** starter kits distributed showed it to have potential for **informing** anglers about the sport-reward fishery. Unfortunately, there were no means for

demonstrating that this demand translated into increased effort or harvest for the northern **squawfish** sport-reward fishery.

Anglers responses **from** the voucher indicated that **<1%** learned about the northern **squawfish** sport-reward fishery from radio (Appendix Table 3-C). The radio spot was broadcast a combined total of 670 times among the four areas during the time periods that it was used. This total was split into 335 insertions between the Portland and The **Dalles radio** markets and 335 insertions between the **Lewiston/Clarkston** and the **Tri-Cities** radio markets.

Radio advertising did generate angler interest in the free northern **squawfish** starter kits as demonstrated by angler requests. It was difficult to demonstrate that radio added any positive results to the sport-reward **fishery** other than for distributing these kits. Continued use of this advertising medium in the **future** will require that the results be somehow documented.

The voucher **questionnaire** provided the only direct method for asking anglers how advertising affected them during the 1994 fishery. When the responses are broken down by type, it becomes apparent that to be **successful**, the sport-reward fishery must use methods of advertisement that stimulate word of mouth communication such as pre-season mailers and newspaper advertising. Data provided by the voucher gave us only a partial picture of how advertising affected anglers since it only surveyed **successful** anglers. The effect of advertising on the fishery's **unsuccessful** anglers is not known. Additional evaluation methods for determining the effect of advertising programs on **unsuccessful** anglers **will** be developed for the 1995 season to address this concern.

800 Hotline

The toll-free squawfish hotline was used by 5,478 users during the season with an average of about 1,100 people per month and peak usage in the month of June (Appendix Figure 6-D). According to AT&T, the average length of call was **2:32** minutes at a cost of \$.44 per call. The busiest days of the week for usage were Monday through Thursday and most calls to the hotline were attempted during the day as opposed to evening or night. The largest number of calls came from the "503" area code, followed by "206," "509" and "208."

The 800 hotline number has generated usage that shows it to be an effective way to provide the public with regularly updated **information** about the northern **squawfish** sport-reward fishery. The relatively **small** average cost of \$.44 per call shows that the hotline is also an **efficient** use of **funds**. In **addition**, the flexibility available to us with the **hotline** allows us to **modify** and improve the product that it provides to the public in response to demand.

Summary

The goal of the 1994 incentive programs for the northern squawfish sport-reward fishery was to increase effort to 100,000 angler days and to increase the harvest rate of northern squawfish so that our exploitation rate is closer to the upper end of the program's 10-20%

exploitation goal. The promotional activities implemented in 1994 did result in a higher harvest level than the 1993 northern squawfish sport-reward fishery and our highest exploitation rate to date. To build on this **foundation**, the 1995 northern **squawfish** sport-reward fishery must continue to offer successful incentives from 1994 (with **modifications** if necessary) and add additional incentives if appropriate.

The goal for the 1995 northern squawfish sport-reward **fishery** should be broadened to aim for increases in both effort and harvest.

To boost effort, the 1995 incentives must accomplish three tasks: (1) entice top anglers from previous seasons to fish more **often**, (2) recruit new anglers that are experienced and well equipped to the northern squawfish sport-reward **fishery**, and (3) attract novice anglers.

To boost harvest, the northern **squawfish** sport-reward fishery must also accomplish three tasks: (1) provide incentives for top anglers to fish longer and/or **harder**; (2) provide information on northern squawfish angling to new, experienced anglers for them to become proficient **squawfish anglers**; (3) and provide direct training to novice anglers so that they **will** become competent northern squawfish anglers.

With the above mentioned goals in mind, the following recommendations are made regarding specific promotional and **advertising** programs for 1995.

1. Increase the reward paid for northern squawfish ≥ 11 inches.
2. Continue the **BPA/co-sponsor** tournament.
3. Use the weekly tournaments for slow periods.
4. Continue tagged northern **squawfish** promotion.
5. **Modify** random drawings to provide more winners.
6. Keep option of extending fishery.
7. Emphasize word-of-mouth advertising methods.
8. Use radio advertising to emphasize specific events.
9. Continue use of 800 hotline; **modify** as necessary.
10. Actively encourage independent tournaments.

Finally, evaluation methods for incentives should be strengthened prior to the start of the 1995 season.

By increasing the reward paid for northern squawfish and by modifying select promotional activities, the 1995 fishery should be **able** to exceed the totals seen for 1994.

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- Vigg, S., **C.C. Burley, D.L. Ward, C. Mallette, S. Smith,** and M. Zimmerman. 1990. Report A in **A.A. Nigro**, editor. Development of a system-wide predator control program: **stepwise** implementation of a predation **index**, predator control fisheries, and evaluation plan in the Columbia River Basin. 1990 Annual Report. Contract DE-B179-90BP07084, Bonneville Power Administration, Portland, Oregon.

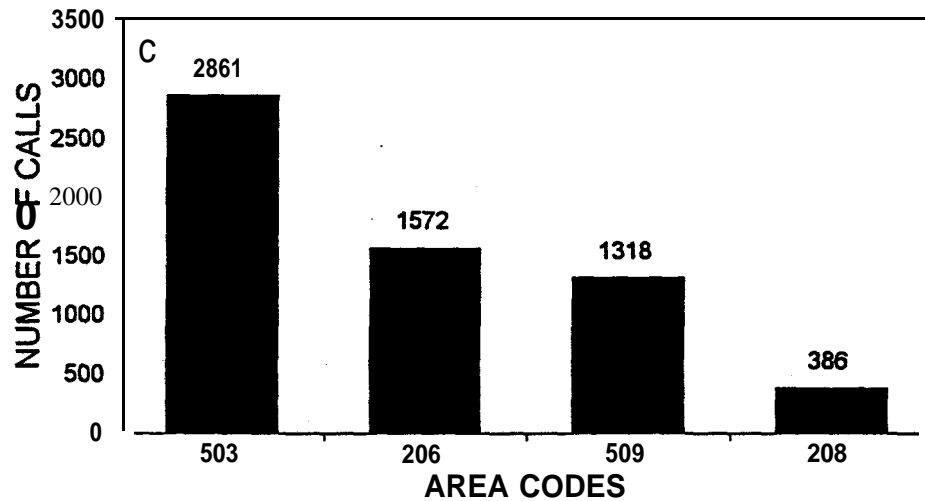
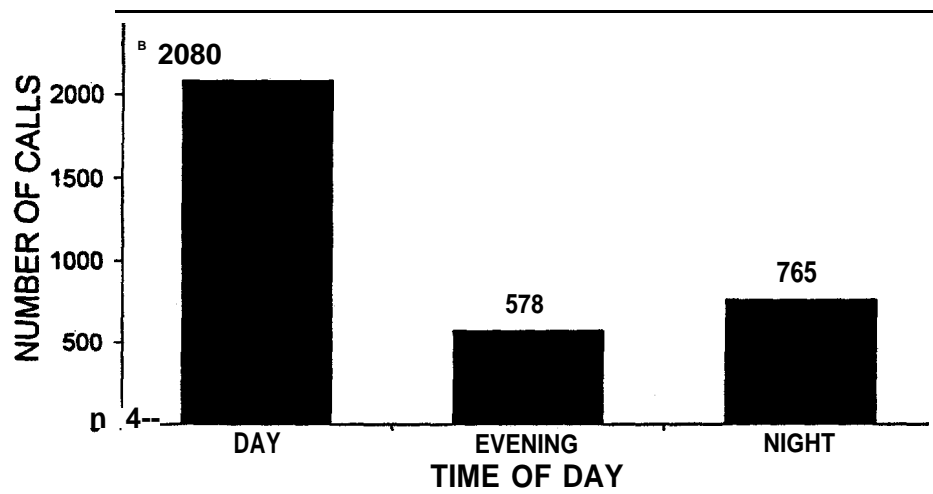
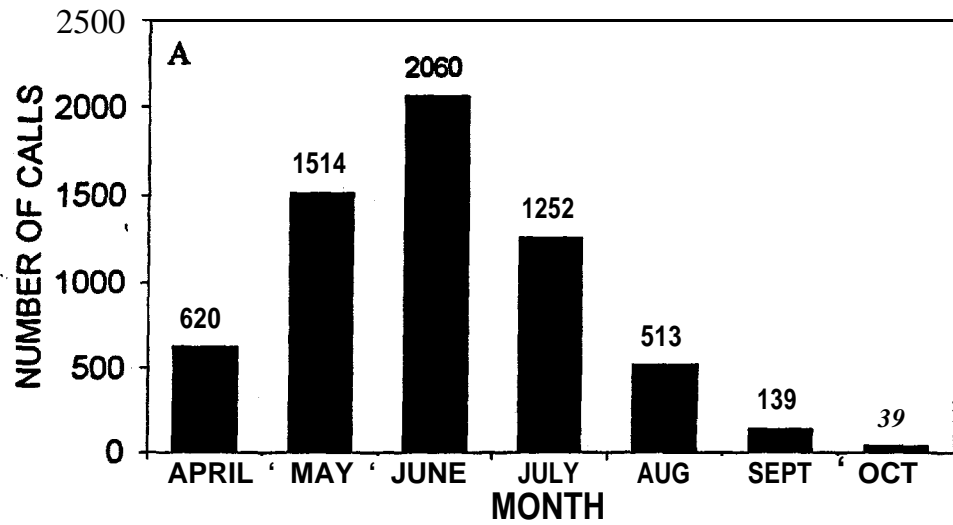


Figure 6D. Northern squawfish hotline usage by month, time of day and by area codes.

APPENDIX E

Phone Survey

Introduction

A telephone survey of non-returning anglers was conducted as part of the evaluation of the 1994 northern **squawfish** sport-reward fishery (Klaybor et al. 1995). Non-returning anglers are defined as anglers who registered to participate in the fishery, but did not return to the registration station to turn in fish and complete an exit interview.

The primary purpose of this study was to estimate non-returning angler harvest of northern squaw-fish and incidental harvest of other fish species. Other objectives were to determine how angler participation was impacted by various promotional programs or by changes in registration station location and hours of operation. The survey also allowed us to record and monitor technician interactions with anglers and other angler concerns with the northern **squawfish** sport-reward fishery.

Methods

Ten percent of non-returning anglers were surveyed from each of the 14 registration sites. Non-returning anglers were selected for survey using a systematic random sampling method. A randomly selected number between 1 and 5 was as a starting point in the weekly registration document files. Every **fifth** registered angler from that point (inclusive) was added to a potential survey list. Calls were made to non-returning anglers from that list until 100A of the non-returning anglers from each site had been surveyed. This process was completed for each week of the **fishery**.

The calling protocol was adopted from Washington State University's Social Science Research Center (Dillman 1978). Up to five attempts were made to contact each angler selected for an interview. Three attempts were made on weekday afternoons or evenings and two attempts on weekend days, unless a **family** member of the angler recommended a specific time to call back.

Survey questions are listed in Appendix Table E-1. Computer programs checked the data for inappropriate values and inconsistencies. In **addition**, a minimum of 5% of each data file was extracted and checked for errors against the original documents.

Table E-1. Telephone questionnaire for non-returning anglers for the 1994 northern squawfish sport-reward fishery.

RESULTS CODES

CALL BACK CODES

HAM - ANSWERING MACHINE
BBz - BUSY
BCB - CALL BACK

DIRECTORY ASSISTANCE CODE

DWN - WRONG NUMBER
DDS - DISCONNECT
BNA - NO ANSWER

COMPLETED CODES

CCM - COMPLETE
CPC - PARTIAL COMPLETE

UNCOMPLETED CODES

IHC - HANDICAPPED
IOT - OTHER
IRN - NOT AVAILABLE
ITR - ABUSIVE
IDD - DECEASED
IDL - DEAF
IRF - REFUSAL
IDC - DON'T CALL AGAIN
IJV - JUVENILE

TIME CODES

WE - WEEK-END
WD - WEEK-DAY

D - DAY
E - EVENING

DAY CALL = 1:30 - 5:30
 EVENING CALL = 5:30 - 9:00

DAY CODES

SUN - SUNDAY
MON - MONDAY
TUE - TUESDAY

WED - WEDNESDAY
THU - THURSDAY
FRI - FRIDAY

SAT - SATURDAY
SuN - SUNDAY

ANGLER **CALLING SCHEDULE**

2 - WD E
 1 - WD D
 1 - WE D
 1 - W E E

RESERVOIR CODES

1 - Below Bonneville
 2 - Bonneville
 3 - The Dalles
 4 - John Day
 5 - McNary
 6 - Ice Harbor
 7 - Lower Monumental
 8 - Little Goose
 9 - Lower Granite

TELEPHONE **QUESTIONNAIRE** FOR **NON-RETURNING** ANGLERS
NORTHERN SQUAWFISH SPORT—REWARD **FISHERY** 1994

A N G L E R NAME INTERVIEWER DATE
DAY TIME

My name is (Interviewer) and I am with the Washington State Northern Squaw Fish Program. Could I speak with (angler name)?

(Angler name) We are interviewing people who registered to fish for northern squawfish. This information will be kept confidential and only used to improve the efficiency of the program. Do you recall registering at (Check station) on (date)? (If no - Remind them with information from the registration form) I have a few questions concerning your fishing trip that I would like to ask you. It will only take about 10 minutes. Is this a good time to complete the questionnaire? (If no) When would be a good time to call back?

We have created maps that divide the Columbia and Snake Rivers into large sections. These maps will help us to determine the effect our program is having on the fish populations in those areas. We are not to trying to locate your favorite fishing hole. I just need to know approximately where you were fishing that day.

Q1. Reservoir Code _____

Q1A. Location Code _____

Q2. Did you catch any fish while you were fishing for northern squawfish?

1. Y E S 2. N O 3. CAN'T REMEMBER _____

4. DIDN'T TARGET _____

If yes: What species did you catch and how many of each?
Please tell me one species at a time so that I can record them.

Were the northern squawfish over or under 11 inches?
(≥ 11 inches NSF-G) (< 11 inches NSF-L)

| Q3 . | SPECIES | Q3A . | QUANTITY | Q3B . | FISH DISP. |
|------|---------|-------|----------|-------|------------|
|------|---------|-------|----------|-------|------------|

| | | |
|-------|-------|-------|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

(9999-CAN'T REMEMBER)

Q3B. What did you do with the fish? Did you:

1. Return them to the water unharmed.
- 2* Kill them and return them to the water.
3. Keep them to eat.
4. Keep them for other uses.

5. Gave them to another angler to turn in.
6. Returned them to the station yourself
(Did you get a voucher?; Do you know the voucher#?;
Do you know why you didn't get a voucher?) .
7. Other

Q3C. Memo

Q4 . Did you catch any fish while you were fishing for other species?

10 Y E_s 2 . N_O 3. CAN'T REMEMBER_____

4. DIDN'T TARGET _____

If yes: What species did you catch and how many of each?
Please tell me one species at a time so that I can record them.

Were the northern squawfish over or under 11 inches?
(≥11 inches NSF-G) (<11 inches NSF-L)

Q5 . SPECIES Q5A . QUANTITY Q5B . FISH DISP.

| | | |
|-------|-------|-------|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

(9999-CAN'T REMEMBER)

Q5B . What did you do with the fish? Did you:

1. Return them to the water unharmed.
2. Kill them and return them to the water.
3. Keep them to eat.
4. Keep them for other uses.
5. Gave them to another angler to turn in.
6. Returned them to the station yourself.
(Did you get a voucher?; Do you know the voucher#?;
Do you know why you didn't get a voucher?)
7. Other

Q5C. Memo

Q6 . Are the checkstations conveniently located for you?

1. YES 2. NO

Q6A. If no: What new locations would you suggest?

Q7 . Has the change in registration hours of operation
(1) increased, (2) not changed, or (3) decreased your
participation in the program?

Q8. Do you plan to register again with the program?

1. YES

2. NO

Q8A. If no: What is the main reason you do not plan to **register** with the program: (Wait for a response, then categorize.)

1. Poor success catching northern squawfish.

2* Registration is too much trouble.

3* Too far to registration site.

4. Other reasons: Q8B. Please explain: _____

Q9. Would you have taken this fishing trip if the Northern Squaw Fish Program did not exist?

1. YES

2. NO

Q10. Has this years promotional programs changed your participation in the Northern Squaw Fish Program, which are:

A. Tagged fish \$50 reward program.

B. Tagged fish \$5,000 reward program.

C. Monthly drawing by region-- \$250.

D. Monthly drawing for total program--\$1,000.

E. Derbies.

1. Increased 2. Not Change 3. Decreased

4. Were you not aware of the new program?

Q11. How would you rate your interaction with the technicians at the check station?

1. Very good

2. Good

3. Poor (Record comments on all number 3 responses)

4* No Interaction

Q12A. Comments

Results and Discussion

Non-returning angler satisfaction with the northern squawfish sport-reward fishery was **high**, since more than 87% responded positively to questions related to **their** interaction with the program. Registration stations were conveniently located for 87.5% of the surveyed **non-returning** anglers (Appendix Table E-2). When asked to suggest other locations, less than 12% of the non-returning anglers requested alternatives. **Surveyed** non-returning angler responses indicate that participation might be significantly increased by adding satellite registration stations at Chinook Landing, Vancouver, and possibly at Longview, since those sites were requested by 31.4%, 11.1%, and **5.2%**, respectively. Only 6.0% of **surveyed** non-returning anglers said their participation decreased as a result of the change in hours of operation during 1994 (Appendix Table E-2). This figure cannot include anglers who registered with the northern **squawfish sport-reward** fishery in prior years, but were unable to do so this year due to the changes in registration station location and hours of operation.

Non-returning anglers represented 47.6% of the total registered anglers for 1994 as compared to 56.7% for 1993. The number of non-returning anglers decreased by 5,289 (**26.7%**) from 1993 while total registered anglers decreased by only 4,456 (12.8%) and returning registered anglers increased by 833 (**5.5%**). Even though overall participation was **down**, both number and percent of anglers that were **successful** increased from 1993. It may be that the loss of participation occurred primarily among anglers who had low success in 1993 rather than as a result of the changes in registration locations and hours of operation.

Almost 97% of surveyed non-returning anglers said they planned to register with the northern squawfish sport-reward fishery again (Appendix Table E-2). From the 3.1% that would not, responses were evenly split between "poor success catching northern **squawfish**" (**0.5%**) and "too **far** to registration site" (**0.6%**) as reasons for not planning to register again. Miscellaneous "other reasons" (**2.0%**) included (1) too busy, (2) not interested, (3) fishing for other species, (4) leaving the **area**, and (5) one angler who didn't want to put his social security number on the voucher.

Approximately 17-18% (averaged over the whole season) of surveyed non-returning anglers were not aware of promotional programs. The programs were generally beneficial and about equally popular, with 42-43% of surveyed non-returning anglers reporting that their participation increased as a result (Table E-2). Less than **1%** of the responses to the promotional programs were unfavorable.

Non-northern **squawfish** species were not significantly impacted by the northern squawfish sport-reward fishery. For example, **smallmouth bass** (*Micropterus dolomieu*) and **peamouth** (*Mylocheilus caurinus*), the most frequently caught incidental species, represent only 7.47% and 3.97%, respectively, of the reported **harvest** while northern **squawfish** were being targeted (Appendix Table E-3). Over 78% (135) of the northern **squawfish** 11 inches or more in length that were harvested by **surveyed** non-returning anglers were targeted by those anglers (Appendix Table E-3). Over 94% (551) of northern squawfish less than 11 inches that were harvested by

surveyed non-returning anglers were targeted. “Harvest by target” data (Appendix Table E-3) could be somewhat misleading. One (1 OYO) chinook salmon (*Oncorhynchus tshawytscha*), 79 (59.8%) **smallmouth** bass, 2 (25.0%) steelhead (*Oncorhynchus mykiss*), 16 (32.0%) walleye (*Stizostedion vitreum*), and two (25.0%) white sturgeon (*Acipenser transmontanus*) were harvested by **surveyed** non-returning anglers while targeting northern **squawfish**. Although the percentages for these incidental species are large, the harvest quantities were low.

Approximately two-thirds (66.6%) of the surveyed non-returning anglers would have gone fishing even if the northern squawfish sport-reward fishery did not exist (Appendix Table E-2). Over 78% of non-northern squawfish species, 67.1% of northern **squawfish** 11 inches or longer, and 84.8% of northern squawfish less than 11 inches were **harvested** by these anglers (Appendix Table E-3). One (100%) chinook **salmon**, 111 (84.1%) **smallmouth** bass, seven (87.5%) **steelhead**, 45 (90.0%) walleye, and eight (100%) white sturgeon were harvested by surveyed **non-returning** anglers who would have gone fishing even if the sport-reward **fishery** did not exist. Nearly 75% of commonly non-targeted species (COT, CP, LCH, NSF, PMO, SK) and over 85% of commonly targeted species (other species in Appendix Table E-4) were harvested by anglers who would have fished even if the northern squawfish sport-reward fishery did not exist. These anglers caught 79.3% of **all** fish harvested by **surveyed** non-returning anglers. The majority (80.7%) of northern squawfish harvested by surveyed non-returning anglers were caught by anglers who would have gone fishing even if the northern **squawfish** sport-reward fishery did not exist. Since these anglers would be targeting non-northern squawfish species if the northern **squawfish** sport-reward fishery did not exist, fishing pressure on other species is probably being reduced as a result of the northern squawfish sport-reward fishery. In **addition**, this factor may more than offset the number of non-northern **squawfish** species harvested by non-returning anglers who would not have gone fishing if the northern squawfish sport-reward fishery did not exist.

Fifteen surveyed non-returning anglers claimed to have returned northern squawfish to the registration station. Explanations for this discrepancy fell into three categories:

1. The registration station was closed when the anglers returned, so the fish were thrown away.
2. The anglers **confused** the date in question with another day when they did return to the registration station.
3. The fish were returned the next day.

Table E-2. Angler responses to categorized questions asked in the 1994 northern squawfish sport reward telephone survey.

| | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|--|-----------|---------|-------------------------|-----------------------|
| Q2. Did you catch any fish while you were fishing for northern squawfish? | | | | |
| 1. YES | 561 | 38.0 | 561 | 38.0 |
| 2. NO | 702 | 47.6 | 1263 | 85.6 |
| 3. CAN'T REMEMBER | 43 | 2.9 | 1306 | 88.5 |
| 4. DIDN'T TARGET | 170 | 11.5 | 1476 | 100.0 |
| Q4. Did you catch any fish while you were fishing for other species? | | | | |
| 1. YES | 232 | 15.7 | 232 | 15.7 |
| 2. NO | 476 | 32.2 | 708 | 48.0 |
| 3. CAN'T REMEMBER | 22 | 1.5 | 730 | 49.5 |
| 4. DIDN'T TARGET | 746 | 50.5 | 1476 | 100.0 |
| Q6. Are the checkstations conveniently located for you? | | | | |
| 1. YES | 1291 | 87.5 | 1291 | 87.5 |
| 2. NO | 185 | 12.5 | 1476 | 100.0 |
| Q7. Has the change in registration hours of operation increased, not changed, or decreased your participation in the program? | | | | |
| 1. INCREASED | 40 | 2.7 | 40 | 2.7 |
| 2. NOT CHANGED | 1348 | 91.3 | 1388 | 94.0 |
| 3. DECREASED | 88 | 6.0 | 1476 | 100.0 |
| Q8. Do you plan to register again with the program? | | | | |
| 1. YES | 1430 | 96.9 | 1430 | 96.9 |
| 2. NO | 46 | 3.1 | 1476 | 100.0 |
| Q8A. If no: What is the main reason you do not plan to register with the program? | | | | |
| 0. Plan to register again. | 1430 | 96.9 | 1430 | 96.9 |
| 1. Poor success catching northern squawfish. | | | | |
| 2. Registration is too much trouble. | 8 | 0.5 | 1438 | 97.4 |
| 3. Too far to registration site. | 9 | 0.6 | 1447 | 98.0 |
| 4. Other reasons. | 29 | 2.0 | 1476 | 100.0 |

Table 2. (Cent.)

| | Frequency | Percent | Cumulative Frequency | Cumulative Percent |
|---|-----------|---------|-------------------------|-----------------------|
| Q9. Would you have taken this fishing trip if the Northern Squawfish Program did not exist? | | | | |
| 1. YES | 983 | 66.6 | 983 | 66.6 |
| 2. NO | 493 | 33.4 | 1476 | 100.0 |
| Q10. Has this year's promotional programs changed your participation in the Northern Squawfish Program, which are: | | | | |
| A. Tagged fish \$50 reward program. | | | | |
| 1. INCREASED | 625 | 42.3 | 625 | 42.3 |
| 2. NOT CHANGED | 591 | 40.0 | 1216 | 82.4 |
| 3. DECREASED | 10 | 0.7 | 1226 | 83.1 |
| 4. NOT AWARE OF THE PROGRAM | 250 | 16.9 | 1476 | 100.0 |
| B. Tagged fish \$5,000 reward program. | | | | |
| 1. INCREASED | 621 | 42.1 | 621 | 42.1 |
| 2. NOT CHANGED | 592 | 40.1 | 1213 | 82.2 |
| 3. DECREASED | 10 | 0.7 | 1223 | 82.9 |
| 4. NOT AWARE OF THE PROGRAM | 253 | 17.1 | 1476 | 100.0 |
| c. Monthly drawing by region-- \$250. | | | | |
| 1. INCREASED | 623 | 42.2 | 623 | 42.2 |
| 2. NOT CHANGED | 577 | 39.1 | 1200 | 81.3 |
| 3. DECREASED | 10 | 0.7 | 1210 | 82.0 |
| 4. NOT AWARE OF THE PROGRAM | 266 | 18.0 | 1476 | 100.0 |
| D. Monthly drawing for total program--\$1,000. | | | | |
| 1. INCREASED | 623 | 42.2 | 623 | 42.2 |
| 2. NOT CHANGED | 575 | 39.0 | 1198 | 81.2 |
| 3. DECREASED | 10 | 0.7 | 1208 | 81.8 |
| 4. NOT AWARE OF THE PROGRAM | 268 | 18.2 | 1476 | 100.0 |
| E. Tournaments. | | | | |
| 1. INCREASED | 635 | 43.0 | 635 | 43.0 |
| 2. NOT CHANGED | 563 | 38.1 | 1198 | 81.2 |
| 3. DECREASED | 10 | 0.7 | 1208 | 81.8 |
| 4. NOT AWARE OF THE PROGRAM | 268 | 18.2 | 1476 | 100.0 |
| Q11. How would you rate your interaction with the technicians at the check station? | | | | |
| 1. VERY GOOD | 1044 | 70.7 | 1044 | 70.7 |
| 2. GOOD | 243 | 16.5 | 1287 | 87.2 |
| 3. POOR | 10 | 0.7 | 1297 | 87.9 |
| 4. NO INTERACTION | 179 | 12.1 | 1476 | 100.0 |

This explanation can be **further** divided into two subgroups. The anglers may actually be **confusing** the dates of two **different** fishing trips (as in Number 2 above), or they may, in **fact**, have kept the fish on ice and returned them with the next day's catch.

Nearly 67% of all fish caught by surveyed non-returning anglers were returned to the water unharmed, including **76.9%** of non-northern squawfish species. Only **5.5%** (10) of the northern squawfish 11 inches or longer that were caught by surveyed non-returning anglers were returned to the water unharmed (Appendix Table E-5). Approximately **39%** (376) of northern squawfish less than 11 inches that were caught by surveyed non-returning anglers were returned to the water unharmed. One (50.0%) chinook **salmon**, 909 (**87.3%**) **smallmouth** bass, 61 (88.4%) **steelhead**, 82 (62.1%) walleye, and 454 (98.3%) white sturgeon were returned to the water unharmed.

The estimated total catch by non-returning anglers (Appendix Table E-6) of northern squawfish ≥ 11 inches was 1,798 (+/- 1,154 fish -- 95% confidence intervals), which was 39.4% less than the 2,968 estimated in 1993. The estimated total catch by non-returning anglers (Appendix Table E-7) of northern **squawfish** < 11 inches was 9,546 (+/- 2,317 fish -- 95% confidence intervals) in 1994, which was over 60% less than the 24,731 estimated in 1993. These decreases are probably due primarily to the increase in number of **successful** anglers and the corresponding decrease in the number of non-returning anglers.

Table E-3. Telephone survey sample harvest and percent by species for anglers that targeted NSF and for anglers that targeted other species.

| SPECIES* | NSF targeted | | Non-NSF targeted | | Totals | |
|----------|--------------|---------|------------------|---------|--------|---------|
| | QTY | % | QTY | % | QTY | % |
| AMS | 11 | 1.04% | 346 | 61.79% | 357 | 22.06% |
| BH | 31 | 2.93% | 3 | 0.54% | 34 | 2.10% |
| C | 0 | 0.00% | 11 | 1.96% | 11 | 0.68% |
| CC | 19 | 1.80% | 6 | 1.07% | 25 | 1.55% |
| CK | 1 | 0.09% | 0 | 0.00% | 1 | 0.06% |
| COT | 73 | 6.90% | 0 | 0.00% | 73 | 4.51% |
| CP | 8 | 0.76% | 0 | 0.00% | 8 | 0.49% |
| CT | 2 | 0.19% | 0 | 0.00% | 2 | 0.12% |
| LCH | 15 | 1.42% | 0 | 0.00% | 15 | 0.93% |
| LMB | 1 | 0.09% | 0 | 0.00% | 1 | 0.06% |
| NSF>=11 | 135 | 12.76% | 38 | 6.79% | 173 | 10.69% |
| NSF<11 | 551 | 52.08% | 33 | 5.89% | 564 | 36.09% |
| PMO | 41 | 3.88% | 1 | 0.18% | 42 | 2.60% |
| RB | 5 | 0.47% | 6 | 1.07% | 11 | 0.68% |
| RU | 11 | 1.04% | 6 | 1.07% | 17 | 1.05% |
| S | 0 | 0.00% | 7 | 1.25% | 7 | 0.43% |
| SH | 1 | 0.09% | 2 | 0.36% | 3 | 0.19% |
| SK | 22 | 2.18% | 1 | 0.18% | 23 | 1.42% |
| SMB | 79 | 7.47% | 53 | 9.46% | 132 | 8.16% |
| SS | 1 | 0.09% | 4 | 0.71% | 5 | 0.31% |
| TR | 3 | 0.28% | 0 | 0.00% | 3 | 0.19% |
| WAL | 16 | 1.51% | 34 | 6.07% | 50 | 3.09% |
| WS | 2 | 0.19% | 6 | 1.07% | 8 | 0.49% |
| YP | 30 | 2.84% | 3 | 0.54% | 33 | 2.04% |
| Totals | 1058 | 100.00% | 560 | 100.00% | 1618 | 100.00% |

.See Appendix B1.

Table E-4. Telephone survey sample harvest and percent by species for anglers that would not have fished without the NSSRF (NSSRF related) and for anglers that would have fished without the NSS (NSSRF unrelated).

| SPECIES* | NSSRF related | | NSSRF unrelated | | Totals | |
|----------|---------------|---------|-----------------|---------|--------|---------|
| | QTY | % | QTY | % | QTY | % |
| AMS | 31 | 9.25% | 326 | 25.41 % | 357 | 22.06% |
| BH | 23 | 6.87% | 11 | 0.86% | 34 | 2.10% |
| c | 0 | 0.00% | 11 | 0.86% | 11 | 0.68% |
| c c | 5 | 1.49% | 20 | 1.56% | 25 | 1.55% |
| CK | 0 | 0.00% | 1 | 0.08% | 1 | 0.06% |
| COT | 61 | 18.21% | 12 | 0.94% | 73 | 4.51 % |
| CP | 3 | 0.90% | 5 | 0.39% | 8 | 0.49% |
| CT | 0 | 0.00% | 2 | 0.16% | 2 | 0.12% |
| LCH | 3 | 0.90% | 12 | 0.94% | 15 | 0.93% |
| LMB | 0 | 0.00% | 1 | 0.08% | 1 | 0.06% |
| NSF>=11 | 57 | 17.01% | 116 | 9.04% | 173 | 10.69% |
| NSF<11 | 89 | 26.57% | 495 | 38.58% | 584 | 36.09% |
| PMO | 17 | 5.07% | 25 | 1.95% | 42 | 2.60% |
| RB | 0 | 0.00% | 11 | 0.86% | 11 | 0.68% |
| RU | 2 | 0.60% | 1 | 0.08% | 3 | 0.19% |
| S | 0 | 0.00% | 7 | 0.55% | 7 | 0.43% |
| SH | 0 | 0.00% | 3 | 0.23% | 3 | 0.19% |
| SK | 2 | 0.60% | 21 | 1.64% | 23 | 1.42% |
| SMB | 21 | 6.27% | 111 | 8.65% | 132 | 8.16% |
| SS | 1 | 0.30% | 4 | 0.31% | 5 | 0.31% |
| TR | 0 | 0.00% | 3 | 0.23% | 3 | 0.19% |
| WAL | 5 | 1.49% | 45 | 3.51% | 50 | 3.09% |
| WS | 0 | 0.00% | 8 | 0.62% | 8 | 0.49% |
| YP | 15 | 4.48% | 18 | 1.40% | 33 | 2.04% |
| Totals | 335 | 100.00% | 1283 | 100.00% | 1618 | 100.00% |

* See Appendix B1.

Table E-5. Questions Q3b and Q5b. Responses regarding how anglers disposed of selected game and sensitive fishes, with quantity and % by disposition within species for each target option.

| Species | 'Disposition' | NSF targeted | | Non-NSF targeted | | Totals | |
|-----------------|---------------|--------------|---------|------------------|---------|--------|--------|
| | | #of | fish % | #of | fish % | #of | fish % |
| Chinook | 1 | 0 | 0.00% | 1 | 100.00% | 1 | 50.00% |
| | 3 | 1 | 100.00% | 0 | 0.00% | 1 | 50.00% |
| NSF >= 11 | 1 | 8 | 5.59% | 2 | 5.00% | 10 | 5.46% |
| | 2 | 24 | 16.78% | 3 | 7.50% | 27 | 14.75% |
| | 3 | 1 | 0.70% | 0 | 0.00% | 1 | 0.55% |
| | 4 | 12 | 8.39% | 31 | 77.50% | 43 | 23.50% |
| | 5 | 27 | 18.88% | 0 | 0.00% | 27 | 14.75% |
| | 6 | 27 | 18.88% | 1 | 2.50% | 28 | 15.30% |
| | 7 | 44 | 30.77% | 3 | 7.50% | 47 | 25.68% |
| NSF < 11 | 1 | 339 | 38.09% | 37 | 52.86% | 376 | 39.17% |
| | 2 | 402 | 45.17% | 23 | 32.86% | 425 | 44.27% |
| | 3 | 0 | 0.00% | 2 | 2.86% | 2 | 0.21% |
| | 4 | 113 | 12.70% | 8 | 11.43% | 121 | 12.60% |
| | 6 | 29 | 3.26% | 0 | 0.00% | 29 | 3.02% |
| | 7 | 7 | 0.79% | 0 | 0.00% | 7 | 0.73% |
| Smallmouth bass | 1 | 534 | 87.11% | 375 | 87.62% | 909 | 87.32% |
| | 3 | 79 | 12.89% | 53 | 12.38% | 132 | 12.68% |
| Steelhead** | 1 | 46 | 95.83% | 15 | 71.43% | 61 | 88.41% |
| | 3 | 2 | 4.17% | 6 | 28.57% | 8 | 11.59% |
| Walleye | 1 | 27 | 62.79% | 55 | 61.80% | 82 | 62.12% |
| | 3 | 15 | 34.88% | 34 | 38.20% | 49 | 37.12% |
| | 7 | 1 | 2.33% | 0 | 0.00% | 1 | 0.76% |
| White Sturgeon | 1 | 215 | 99.08% | 239 | 97.55% | 454 | 98.27% |
| | 3 | 2 | 0.92% | 6 | 2.45% | 8 | 1.73% |

.Q3b and Q5b.

What did you do with the fish? Did you:

1. Return them to the water unharmed?
2. Kill them and return them to the water?
3. Keep them to eat?
4. Keep them for other uses?
5. Give them to another angler to turn in?
6. Return them to the station yourself?
7. Other?

** Includes SH and SS.

Table E-6. Total catch estimates of NSF over 11 inches by N/R anglers, along with confidence intervals and the percent of the catch returned to the water unharmed.

| REGISTRATION STATIONS | NON RETURN TOTAL | NON RETURN SAMPLE | NUM.NSF CAUGHT OVER 11" | EST. NSF CAUGHT OVER 11" | OVER 11" VARIANCE | OVER 11" CONFIDENCE INTERVAL | NUM.NSF RETURNED OVER11 | % of NSF RETURNED UNHARMED |
|-----------------------|------------------|-------------------|-------------------------|--------------------------|-------------------|------------------------------|-------------------------|----------------------------|
| CATHLAMET | 810 | 81 | 7 | 70 | 0.59 | 131 | 0 | 0.00 |
| KALAMA | 1045 | 104 | 10 | 100 | 0.61 | 152 | 0 | 0.00 |
| GLEASON | 1614 | 161 | 52 | 621 | 15,86 | 961 | 0 | 0.00 |
| WASHOUGAL | 1669 | 166 | 8 | 80 | 0,38 | 162 | 0 | 0.00 |
| FISHERY | 1821 | 190 | 43 | 412 | 5.49 | 686 | 3 | 0.07 |
| HAMILTON | 1081 | 112 | 13 | 12s | 0.42 | 125 | 5 | 0.38 |
| BINGEN | 394 | 39 | 2 | 20 | 0,24 | 59 | 0 | 0.00 |
| DALLES | 817 | 84 | 4 | 39 | 0.25 | 84 | 0 | 0.00 |
| GILES FRENCH | 839 | 83 | 6 | 61 | 0.21 | 80 | 1 | 0.17 |
| UMATILLA | 710 | 71 | 8 | 80 | 1,21 | 176 | 0 | 0.00 |
| COLUMBIA P. | 525 | 54 | 3 | 29 | 0.16 | 64 | 0 | 0.00 |
| VERNITA | 564 | 61 | 5 | 46 | 0.27 | 71 | 1 | 0.20 |
| HOOD P. | 891 | 95 | 4 | 38 | 0.17 | 71 | 0 | 0.00 |
| GREENBELT | 1705 | 175 | 18 | 176 | 2.25 | 366 | 0 | 0.00 |
| TOTAL | 14485 | 1476 | 183 | 1798 | 2.61 | 1164 | 10 | 0.06 |

Table E-7. Total catch estimates of NSF under 11 inches by N/R anglers, along with confidence intervals and the percent of the catch returned to the water unharmed.

| REGISTRATION STATIONS | NON RETURN TOTAL | NON RETURN SAMPLE | NUM.NSF CAUGHT UNDER11 | EST. NSF CAUGHT UNDER 1 | UNDER11 VARIANCE | UNDER11 CONFIDENCE INTERVAL | NUM.NSF RETURNED UNDER11 | % of NSF RETURNED UNHARMED |
|-----------------------|------------------|-------------------|------------------------|-------------------------|------------------|-----------------------------|--------------------------|----------------------------|
| CATHLAMET | 810 | 81 | 113 | 1130 | 31.36 | 9S6 | 52 | 0.46 |
| KALAMA | 1045 | 104 | 163 | 1638 | 27.01 | 1o11 | 47 | 0.29 |
| GLEASON | 1614 | 161 | 256 | 2S66 | 31 | 1344 | 82 | 0.32 |
| WASHOUGAL | 1669 | 166 | 105 | 1056 | 7.24 | 662 | 35 | 0.33 |
| FISHERY | 1821 | 190 | 70 | 671 | 2.05 | 358 | 13 | 0.19 |
| HAMILTON | 1081 | 112 | 34 | 328 | 1.95 | 270 | 6 | 0.24 |
| BINGEN | 394 | 39 | 31 | 313 | 4.19 | 245 | 16 | 0.s2 |
| DALLES | 817 | 84 | 45 | 438 | 4.47 | 357 | 28 | 0.62 |
| GILES FRENCH | 839 | 83 | 44 | 44s | 5.61 | 414 | 32 | 0.73 |
| UMATILLA | 710 | 71 | 21 | 210 | 3.56 | 302 | 12 | 0.67 |
| COLUMBIA P. | 525 | 54 | 32 | 311 | 14 | 506 | 8 | 0.2s |
| VERNITA | 564 | 61 | 12 | 111 | 0.44 | 90 | 11 | 0.92 |
| HOOD P. | 891 | 95 | 5 | 47 | 0.11 | 57 | 3 | 0.60 |
| GREENBELT | 1705 | 175 | 29 | 283 | 0.89 | 230 | 29 | 1.00 |
| TOTAL | 14485 | 1476 | 960 | 9S46 | 10.51 | 2317 | 376 | 0 . 3 9 |

APPENDIX F

Harvest Evaluation

Introduction

The northern squawfish sport-reward fishery attracts thousands of anglers annually to fish for northern squawfish in the Columbia and Snake rivers. The harvest of fishes other than northern squawfish by these anglers is estimated by the Washington Department of Fish and Wildlife (WDFW) and used by the Oregon Department of Fish and Wildlife (ODFW) to ensure that no fishes are **overharvested** as a result of the northern squawfish sport-reward fishery. In the interest of brevity, harvest estimates discussed in this report are limited to **smallmouth** bass (*Micropterus dolomieu*), walleye (*Stizostedion vitreum*), steelhead (*Oncorhynchus mykiss*), white sturgeon (*Acipenser transmontanus*), chinook salmon (*Oncorhynchus tshawytscha*) and northern squawfish under 11 inches. Total harvest estimates, which includes returning angler and **non-returning** angler harvest, are made for each species.

If the harvest from non-returning anglers is similar to that of returning anglers, then sampling can be limited to either and harvest estimates obtained for both. Telephone survey estimates of non-returning angler harvest are used to estimate returning angler harvest and the results compared to harvest estimates derived from returning anglers. The comparison results as well as information from the voucher and exit interview data are used to create the most economical, practical and simple sampling method for estimating the 1995 incidental catch. The problems associated with defining incidental catch for the northern squawfish sport-reward fishery are also discussed and solutions proposed.

Methods

Anglers **surveyed** in the 1994 exit interview were asked how many fish they harvested (caught and kept only), but no data was recorded on total catch (includes released and kept fish). The incidental catch estimates in this report were therefore limited to total angler harvest and angler harvest while targeting northern **squawfish**.

We combined the voucher and exit data to achieve a more accurate estimate of returning angler harvest. If an angler reported harvesting a different number of fish in the exit interview and voucher **data**, then the highest number was recorded in a high data set (**H**) and the low recorded in a low data set (L). If an angler only recorded an exit or voucher questionnaire, then the recorded harvest value was used for both H and L values. Equal voucher and exit values were recorded as equal for both H and L values. The H estimate should be considered the highest possible **harvest** and the L estimate the lowest.

Phone **survey** (P) data for non-returning anglers were limited to **harvested** fish for comparison to returning angler data. The phone **survey** estimates for returning anglers were calculated by dividing the number of fish caught by all non-returning anglers sampled in each registration station by the number of angler days fished and then multiplying by the number of returning anglers for that registration station. The **10%** sample of non-returning anglers was assumed to be representative of the non-returning angler population.

Harvest estimates were made for registered anglers (all anglers that participated in the program) by adding the P estimate to the H or L estimate.

Results and Discussion

P estimates for returning angler harvest were lower than L or H estimates for **all** fishes and four out of six P estimates were lower for returning angler harvest while targeting northern **squawfish** (Appendix Table F- 1). The P harvest estimates for **smallmouth** bass were approximately 50% less than either L or H estimates and northern squawfish under 11 inches estimates were approximately 70% less (**Appendix** Table F-1). The total P estimates were much closer to L or H estimates for white **sturgeon**, walleye, chinook and steelhead, but the P estimates were **further** from L or H estimates when compared by registration station (Appendix Table F-1). Differences between the P estimates and the L or H estimates may be due in part to differences in sampling design. The P estimates were derived from a 10% sample of non-returning anglers and the L and H estimates came **from** surveying approximately 96% of the returning anglers. The smaller sample size of the P estimates could cause greater **variability** among sample estimates, but the large number of P estimates that were lower than either L or H estimates (10 out of 12; Appendix Table F-1) leads us to conclude that non-returning anglers may in fact catch less fish than returning anglers. The data indicates that returning angler harvest cannot be accurately estimated **from** non-returning angler **data**, therefore, **future** estimates of returning and **non**-returning angler harvest should be derived from sampling each population separately.

The 1994 northern squawfish sport-reward fishery was the first year that harvest estimates were made for all anglers registered with the northern **squawfish** sport-reward **fishery** (Appendix Tables F-2 and F-3). Total harvest represents the harvest reported by all anglers irrespective of the type of fish the angler was targeting and should be considered the maximum fish mortality attributable to the northern squawfish sport-reward fishery, excluding hooking **mortality** from fish caught and released. Harvest while targeting northern squawfish represented a more reasonable estimate of northern squawfish sport-reward fishery's **harvest**, since targeted fish were excluded. **Salmonids** (chinook and **steelhead**) were harvested the least by anglers targeting northern **squawfish**, followed by white sturgeon and walleye (**Appendix** Tables F-2 and F-3). Anglers that target northern squawfish **infrequently** harvest **steelhead**, since they were responsible for only 12% of the estimated total **steelhead** harvest (Appendix Table F-3). **Smallmouth** bass and northern **squawfish** under 11 inches were the most vulnerable to harvest by northern **squawfish** sport-reward fishery anglers and were commonly harvested by anglers targeting northern **squawfish** (Appendix Tables F-2 and F-3).

Many fishermen that target fishes other than northern **squawfish**, such as **smallmouth** bass, register with the northern squawfish sport-reward fishery to collect the reward on incidentally caught northern **squawfish**. Reasonably, the fish caught by these anglers should not be counted as incidental catch for the northern **squawfish** sport-reward fishery. The 1995 northern squawfish sport-reward fishery will produce catch (includes harvested plus released fish) and harvest estimates only for anglers targeting northern **squawfish**, since these estimates provide the best measure of the northern squawfish sport-reward fishery's incidental harvest.

Returning anglers were sampled for harvest data in 1994 at the exit interview and on the voucher questionnaire. The voucher required additional time for anglers to complete and for the Pacific States Marine Fisheries Commission (**PSMFC**) to proof and return to angler if incomplete. Anglers frequently **filled** out the voucher incorrectly, partially due to its design and because no one was available for clarification. The exit **interview** delayed anglers slightly at the registration station, but the angler's memory of the day's catch was fresh and the technician was available to answer questions. Returning anglers will be surveyed in 1995 at the exit interview and the voucher questionnaire will be eliminated. Approximately 50% of the returning anglers will be surveyed to obtain the highest sample size without excessively slowing down the exit interview process. Returning angler catch estimates from the exit interview **will** be added to the **non-**returning angler catch estimates from the telephone survey to derive total catch estimates for all registered anglers.

Table F-1. Estimated returning angler harvest and harvest while targeting northern squawfish by registration location and species.

| Returning Angler Harvest | | | | | | | | | | | | | | | | | | |
|--------------------------|-----------------|------|------|----------------|----|----|---------|-----|-----|----------------|---|---|-----------|----|---------|---------------|-------|------|
| Location | Smallmouth 6SSS | | | White Sturgeon | | | Walleye | | | Chinook Salmon | | | Steelhead | | | NSF under 11" | | |
| | H | L | P | H | L | P | H | L | P | H | L | P | H | L | P | H | L | P |
| Cathlamet | 17 | 17 | 0 | 7 | 7 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 7 | 23 | 1154 | 1116 | 6S7 |
| Kalama | 12 | 12 | 0 | 2 | 2 | 7 | 3 | 3 | 0 | 0 | 0 | 7 | 7 | 7 | 14 | 1239 | 1216 | '826 |
| Gleason | 431 | 405 | 172 | 3 | 3 | 0 | 44 | 44 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 2434 | 2255 | 1763 |
| W | 385 | 373 | 328 | 24 | 24 | 36 | 47 | 42 | 139 | 0 | 0 | 0 | 4 | 4 | 0 | 2734 | 259S | 864 |
| The Fishery | 204 | 198 | 52 | 21 | 21 | 0 | 80 | 73 | 78 | 0 | 0 | 0 | 50 | 50 | 39 | 2925 | 2849 | 737 |
| Hamilton | 78 | 76 | 212 | 9 | 9 | 0 | 23 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1613 | 1542 | 393 |
| Bingen | 122 | 115 | 67 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 609 | 594 | 251 |
| The Dalles | 192 | 183 | 71 | 8 | 8 | 0 | 131 | 122 | 18 | 1 | 1 | 0 | 4 | 4 | 0 | 997 | S6S | 152 |
| Giles French | 287 | 275 | 14 | 1 | 1 | 0 | 230 | 219 | 246 | 3 | 3 | 0 | 3 | 3 | 0 | 992 | 978 | 173 |
| Umatilla | 155 | 154 | 29 | 4 | 4 | 15 | 82 | 75 | 73 | 0 | 0 | 0 | 0 | 0 | 0 | 647 | 614 | 66 |
| Columbia Point | S8 | 85 | 85 | 8 | 7 | 0 | 6 | 6 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 744 | 714 | 255 |
| Vernita | 52 | 52 | 0 | 2 | 2 | 0 | 16 | 16 | 13 | 4 | 4 | 0 | 7 | 7 | 0 | 616 | 615 | 13 |
| Hood Park | 36 | 34 | 43 | 0 | 0 | 5 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 387 | 38? | 10 |
| Greenbelt | 489 | 463 | 311 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 6 | 1648 | 1576 | 0 |
| Total | 2546 | 2442 | 13S4 | 90 | 89 | 76 | 667 | 628 | 597 | 8 | S | 7 | 9 | 0 | s 0 6 4 | 1S739 | 16025 | 6212 |

| Returning Angler Harvest While Targeting Northern Squawfish | | | | | | | | | | | | | | | | | | |
|---|-----------------|------|-----|----------------|----|----|---------|-----|-----|----------------|---|---|-----------|----|----|---------------|-------|------|
| Location | Smallmouth Bass | | | White Sturgeon | | | Walleye | | | Chinook Salmon | | | Steelhead | | | NSF under 11" | | |
| | H | L | P | H | L | P | H | L | P | H | L | P | H | L | P | H | L | P |
| Cathlamet | 17 | 17 | 0 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10\$3 | 1058 | 6s7 |
| Kalama | 10 | 10 | 0 | 2 | 2 | 7 | 3 | 3 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 1074 | 1054 | 799 |
| Gleason | 394 | 377 | 132 | 3 | 3 | 0 | 15 | 15 | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 206s | 1907 | 1682 |
| Washougal | 318 | 315 | 303 | 17 | 17 | 0 | 17 | 17 | 63 | 0 | 0 | 0 | 1 | 1 | 0 | 2165 | 2092 | 806 |
| The Fishery | 1S5 | 183 | 52 | 1S | 18 | 0 | 41 | 36 | 26 | 0 | 0 | 0 | 8 | 8 | 26 | 2783 | 2728 | 659 |
| Hamilton | 65 | 65 | 60 | 9 | 9 | 0 | 25 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1407 | 1357 | 348 |
| Bingen | 96 | 91 | 33 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 531 | 519 | 251 |
| The Dalles | 138 | 134 | 27 | 4 | 4 | 0 | 62 | 59 | 16 | 1 | 1 | 0 | 0 | 0 | 0 | 857 | 831 | 152 |
| Giles French | 180 | 173 | 14 | 1 | 1 | 0 | 150 | 144 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 861 | 650 | 159 |
| Umatilla | 123 | 123 | 15 | 4 | 4 | 0 | 25 | 25 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 592 | 566 | 59 |
| Columbia Point | 52 | 52 | 64 | 4 | 4 | 0 | 6 | 6 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 661 | 641 | 255 |
| Vernita | 45 | 45 | 0 | 1 | 1 | 0 | 15 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 524 | 524 | 0 |
| Hood Park | 16 | 16 | 34 | 0 | 0 | 5 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 319 | 319 | 5 |
| Greenbelt | 276 | 271 | 10S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1464 | 1395 | o |
| Totals | 1915 | 1672 | S43 | 67 | 67 | 12 | 364 | 350 | 166 | 2 | 2 | 7 | 11 | 11 | 26 | 1639S | 15S41 | 5S64 |

H - Highest possible returning angler harvest estimate.
L - Lowest possible returning angler harvest estimate,
P - Telephone survey returning angler harvest estimate.

Table F-2. Estimated registered angler total harvest and harvest while targeting northern squawfish for smallmouth bass, white sturgeon and walleye by registration location. - - -

| Estimated Total Hawest | | | | | | | | | | | | | | | | | | |
|------------------------|-----------------|------|------|------|------|-----|----------------|----|----|-----|-----|---------|-----|-----|------|-------|----|---|
| Location | Smallmouth Bass | | | | | | White Sturgeon | | | | | Walleye | | | | | | |
| | P | H | L | H | t | u | P | H | L | Ht | Lt | P | H | L | H | t | u | |
| Cathlamet | o | 17 | 17 | 17 | 17 | 17 | 10 | 7 | 7 | 17 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Kalama | o | 12 | 12 | 12 | 12 | 12 | 10 | 2 | 2 | 12 | 12 | 0 | 3 | | 3 | 3 | 3 | |
| Gleason | 170 | 431 | 406 | 601 | 575 | | 0 | 3 | | 3 | 3 | 30 | 44 | | 44 | 74 | 74 | |
| Washougal | 26 | 13 | 5 | 3 | 7 | 3 | 30 | 24 | | 24 | 54 | 111 | 47 | 42 | 156 | 163 | | |
| The Fishery | 3 | s | 2 | 0 | 4 | 1 | o | 21 | 21 | 21 | 21 | 5 | s | s | 0 | 7 | 3 | |
| Hamilton | 135 | 7e | 76 | 211 | 211 | | 0 | 9 | 9 | 9 | 9 | 0 | 2 | 3 | 2 | 3 | 2 | 3 |
| Bingen | 40 | 122 | 115 | 162 | 155 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | |
| The Dalles | 7S | 162 | 163 | 270 | 261 | | 0 | 8 | 8 | 8 | 8 | 19 | 131 | 122 | 150 | 141 | | |
| Giles French | 10 | 287 | 275 | 267 | 2S5 | | 0 | 1 | 1 | 1 | 1 | 172 | 230 | 219 | 402 | 361 | | |
| Umatilla | 40 | 155 | 154 | 165 | 164 | | 20 | 4 | 4 | 24 | 24 | 100 | 62 | 75 | 1s2 | 175 | | |
| Columbia Point | 7 | s | s | s | 65 | 166 | 0 | 8 | 7 | 8 | 7 | 0 | 6 | 6 | 6 | 6 | 6 | |
| Vernita | 0 | 5 | 2 | 52 | 52 | 52 | 0 | 2 | 2 | 2 | 2 | 9 | 16 | 16 | 25 | 25 | | |
| Hood Park | 6 | 4 | 3 | 6 | 34 | 120 | 9 | 0 | 0 | 9 | 9 | 0 | 4 | 4 | 4 | 4 | 4 | |
| Greenbelt | 3 | 6 | 0 | 4 | S | 6 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total | 1294 | 2546 | 2442 | 3840 | 3736 | | 79 | 90 | 88 | 169 | 168 | 499 | 667 | 628 | 1166 | 11127 | | |

| Estimated Harvest While Targeting Northern Squawfish | | | | | | | | | | | | | | | | |
|--|-----------------|------|------|------|------|----------------|----|----|----|----|---------|-----|-----|-----|-----|--|
| Location | Smallmouth Base | | | | | White Sturgeon | | | | | Walleye | | | | | |
| | P | H | L | Ht | U | P | H | L | Ht | Lt | P | H | L | Ht | Lt | |
| Cathlamet | 0 | 17 | 17 | 17 | 17 | 0 | 4 | 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | |
| Kalama | 0 | 10 | 10 | 10 | 10 | 10 | 2 | 2 | 12 | 12 | 0 | 3 | 3 | 3 | 3 | |
| Gleason | 130 | 364 | 377 | 524 | 607 | 0 | 3 | 3 | 3 | 3 | 30 | 15 | 15 | 45 | 45 | |
| Washougal | 241 | 318 | 315 | 556 | 66S | 0 | 17 | 17 | 17 | 17 | 50 | 17 | 17 | 67 | 67 | |
| The Fishery | 36 | 185 | 183 | 223 | 221 | 0 | 18 | 18 | 16 | 18 | 19 | 41 | 3s | 60 | 65 | |
| Hamilton | 3 s | 6 | 5 | 66 | 104 | 0 | 9 | 9 | 9 | 9 | 0 | 2 | 5 | 2 | 6 | |
| Bingen | 20 | es | 91 | 116 | 111 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | |
| The Dalles | 29 | 138 | 134 | 167 | 163 | 0 | 4 | 4 | 4 | 4 | 19 | 62 | 56 | 81 | 78 | |
| Giles French | 10 | 1s0 | 173 | 160 | 1s3 | 0 | 1 | 1 | 1 | 1 | 0 | 150 | 144 | 160 | 144 | |
| Umatilla | 20 | 123 | 123 | 143 | 143 | 0 | 4 | 4 | 4 | 4 | 4 | 0 | 2 | 5 | 6 | |
| Columbia Point | 5 s | s | 2 | 62 | 110 | 0 | 4 | 4 | 4 | 4 | 0 | | 6 | 6 | 6 | |
| Vernits | 0 | 4 | 5 | 4 | 6 | 0 | 1 | 1 | 1 | 1 | 0 | | 15 | 15 | 15 | |
| Hood Park | 6S | 16 | 16 | 82 | S2 | 9 | 0 | 0 | 9 | 9 | 0 | 2 | 2 | 2 | 2 | |
| Greenbelt | 127 | 276 | 271 | 403 | 36S | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Total | 778 | 1915 | 1872 | 2663 | 2S50 | 19 | 67 | 67 | 66 | 86 | 156 | 364 | 350 | 522 | 508 | |

P - Non-returning angler harvest estimate.
H - Highest possible registered angler harvest estimate.
L - Lowest possible registered angler harvest estimate.
Ht = P+H
Lt = P+L

Table F-3. **Estimated registered angler total harvest and harvest while targeting northern squawfish for chinook salmon, steelhead and NSF under 11-**

| Estimated Total Harvest | | | | | | | | | | | | | | | | |
|-------------------------|----------------|---|---|----|----|-----------|----|----|-----|-----|---------------|------|-------|-------|-------|-------|
| Location | Chinook Salmon | | | | | Steelhead | | | | | NSF under 11" | | | | | |
| | P | H | L | Ht | Lt | P | L | Ht | Lt | P | H | L | Ht | Lt | | |
| Cathlamet | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 7 | 7 | 27 | 27 | 610 | 1134 | 1116 | 1764 | 1726 |
| Kalama | 10 | 0 | 0 | 10 | 10 | 2 | 0 | 7 | 7 | 27 | 27 | 11SS | 1239 | 1216 | 2405 | 2S62 |
| Gleason | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1744 | 2434 | 2235 | 4178 | 369e |
| Washougal | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 4 | 4 | 4 | 704 | 2734 | 2599 | 3436 | 3303 |
| The Fishery | 0 | 0 | 0 | 0 | 0 | 29 | 50 | 50 | 79 | 79 | 79 | 546 | 2925 | 2849 | 3471 | 3395 |
| Hamilton | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 251 | 1613 | 1S42 | 1864 | 1793 |
| Bingen | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | 3 | 152 | 609 | 594 | 761 | 746 |
| The Dalles | 0 | 1 | 1 | 1 | 1 | 0 | 4 | 4 | 4 | 4 | 4 | 165 | S97 | Sea | 1162 | 1133 |
| Giles French | 0 | 3 | 3 | 3 | 3 | 0 | 3 | 3 | 3 | 3 | 3 | 121 | 992 | 97a | 1113 | lose |
| Umatilla | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 90 | 647 | 614 | 737 | 704 |
| Columbia Point | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 233 | 744 | 714 | 977 | e47 |
| Vernita | 0 | 4 | 4 | 4 | 4 | 0 | 7 | 7 | 7 | 7 | 7 | 9 | 616 | 61S | 625 | 624 |
| Hood Park | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 3s7 | 387 | 406 | 406 |
| Greenbelt | 0 | 0 | 0 | 0 | 0 | 10 | 3 | 3 | 13 | 13 | 13 | 0 | 1648 | 1578 | 1648 | 1578 |
| Total | 10 | 8 | 8 | 18 | 18 | 79 | 80 | 90 | 169 | 169 | 169 | 5810 | 18739 | 18025 | 24549 | 23833 |

| Estimated Harvest While Targeting Northern Squawfish | | | | | | | | | | | | | | | | | | | | | | | |
|--|----------------|---|---|----|----|-----------|---|---|----|----|----|---------------|------|------|-------|-------|-------|-------|---|---|---|---|---|
| Location | Chinook Salmon | | | | | Steelhead | | | | | | NSF under 11" | | | | | | | | | | | |
| | P | H | L | Ht | Lt | P | H | L | H | t | u | P | H | L | Ht | Lt | | | | | | | |
| Cathlamet | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 810 | 109S | 10S6 | 1703 | 16S6 | | | | | | | |
| Kalama | 10 | 0 | 0 | 10 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 1125 | 1074 | 1034 | 2199 | 2179 | | | | | | | |
| Gleason | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1664 | 2068 | 1907 | 3732 | 3571 | | | | | | | |
| Washougal | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 64321 | 65 | 2092 | 2808 | 2735 | | | | | | | |
| The Fishery | 0 | 0 | 0 | 0 | 0 | 1 | s | 8 | 8 | 2 | 7 | 2 | 7 | 46S | 2763 | 2728 | 3272 | 3217 | | | | | |
| Hamilton | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 222 | 1407 | 1357 | 162s | 1579 | | | | | | | |
| Bingen | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 152 | 531 | 519 | 663 | 671 | | | | | | | |
| The Dalles | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 165 | 637 | 831 | 1022 | e9a | | | | | | | |
| Giles French | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 111 | 861 | 650 | 972 | 961 | | | | | | | |
| Umatilla | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 5 | 9 | 2 | 5 | 6 | 6 | 7 | 2 | 6 | 4 | 6 |
| Columbia Point | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 23s | 661 | 641 | 894 | 874 | | | | | | | |
| Vamita | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 524 | 524 | 324 | 524 | | | | | | | |
| Hood Park | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 319 | 319 | 32S | 326 | | | | | | | |
| Greenbelt | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1464 | 1395 | 1464 | 1395 | | | | | | | |
| Total | 1 | 0 | 2 | 2 | 1 | 2 | 1 | 2 | 19 | 11 | 11 | 30 | 30 | 5503 | 16399 | 15841 | 21602 | 21344 | | | | | |

P - Non-returning angler harvest estimate.

H - Highest possible registered angler harvest estimate.

L - Lowest possible registered angler harvest estimate.

Ht = P+H

Lt = P+L

APPENDIX G

Cost Analysis

Introduction

Evaluation of northern squawfish sport-reward fishery registration station costs was previously conducted by Dr. Susan **Hanna**, Oregon State University (**Hanna et al. 1993**). Cost evaluation was conducted for the 1994 northern **squawfish** sport-reward fishery by the Washington Department of Fish and Wildlife (**WDFW**). The total expenditures and the expenditures per northern **squawfish** were compared among registration stations. The average **expenditures** per northern squawfish were compared for 1992, 1993 and 1994. The data were used to determine the effect of cost saving measures implemented in 1994 and to influence management decisions for 1995.

Methods

Cost per registration station was calculated by (1) determining the portion of the **supervising** biologist's pay that is associated with each respective registration **station**, (2) totaling scientific **technician** 1's, 2's and intermittent technician pay for each registration **station**, and (3) determining breakdown of costs for field offices (rent, utilities, etc.) and vehicle rental and gasoline for each registration station. Appendix Table G-1 shows a sample breakdown of costs used to calculate the expenditures for each registration station.

Cost per northern **squawfish** by registration station was determined by dividing the total cost of the registration station by the total northern squawfish harvested at that registration station.

Harvest totals and operation costs associated with satellite stations were included in the cost for each parent registration station.

Results and Discussion

The average cost per registration station in 1994 was \$43,292 and ranged **from** \$32,793 at The **Dalles** to \$50,431 at **Cathlamet** (Appendix Table G-2). The cost per registration station was predominantly influenced by travel costs and overtime pay associated with the distance technicians must travel from the field **office** to the registration station and fish processing facility. Busy registration stations also require more technician hours. The costs associated with the satellite station **trial** increased expenses for certain registration stations (Appendix Table G-2).

Appendix Table G-1. Sample breakdown of the costs used to calculate the total expenditure for each registration **station**, 1992-1994.

| Item | Quantity | unit cost | Total COST |
|---|-----------|-------------------|-------------------|
| PERSONNEL: | | | |
| Fisheries Biologist | 2.5 | \$2,047.00 | \$5,117.50 |
| Sci. Tech 2 (1 position) | | | |
| REG HOURS | 994 | \$10.72 | \$10,655.68 |
| O.T. HOURS | 29 | \$16.08 | \$466.32 |
| Sci. Tech 1 (1 position) | | | |
| REG HOURS | 892 | 9.34 | \$8,331.28 |
| O.T. HOURS | 30 | \$14.01 | \$420.30 |
| Sci. Tech 1 (Intermittent) | | | |
| REG HOURS | 324.5 | \$9.34 | \$3,030.83 |
| O.T. HOURS | 4 | \$14.01 | \$56.04 |
| SHIFT DIFF | 584.5 | \$0.50 | \$292.25 |
| SUBTOTAL: | | | \$28,370.20 |
| FRINGE BENEFITS | | | |
| Full-time Employees | | | \$1,688.78 |
| Part-time Employees | | | \$2,948.69 |
| SUBTOTAL: | | | \$4,637.46 |
| SUPPLIES: | | | |
| (Purchased from previous years. All items still in use.) | | | \$0.00 |
| OPERATION AND MAINTENANCE: | | | |
| Field office rental | 5 | \$200.00 | \$1,000.00 |
| Van rental (PER MONTH) | 5 | \$949.00 | \$4,745.00 |
| *Gas (PER MONTH) | 5 | \$139.83 | \$699.15 |
| SUBTOTAL: | | | \$6,444.15 |
| Indirect Costs: | | | |
| WDFW rate of 38.7 percent of salaries | | | \$10,979.27 |
| TOTAL | | | \$50,431.08 |

*Varies by registration station.

Appendix Table G-2. Total expenditure, harvest and expenditure per northern squawfishS11 inches by registration location in 1994.

| Registration station | Total expenditure | Total harvest | Expenditure per northern squawfish |
|------------------------|-------------------|---------------|---|
| Cathlamet | \$50,431.08 | 5,591 | \$ 9.02* |
| Kalama | 48,546.28 | 3,703 | 13.10 * |
| M.J. Gleason | 48,878.52 | 10,742 | 4.55 |
| Camas/Washougal | 47,099.68 | 9,105 | 5.17 |
| The Fishery | 37,930.25 | 27,935 | 1.36 |
| Hamilton Island | 36,170.51 | 13,732 | 2.63 |
| Bingen | 35,816.95 | 5,038 | 7.10 * |
| The Dalles | 32,793.04 | 7,136 | 4.59 |
| Giles French | 45,013.12 | 13,430 | 3.35 |
| Umatilla | 38,971.10 | 1,586 | 24.57 |
| Columbia Point Park | 38,289.33 | 6,133 | 6.24 |
| Vemita | 40,097.55 | 11,597 | 3.45 |
| Hood Park | 38,094.92 | 4,116 | 9.25 |
| Greenbelt | <u>45,779.22</u> | <u>9,593</u> | <u>4.77 *</u> |
| AVERAGE | \$43,292.78 | 9,245 | \$ 4.68 |

* Satellite station northern **squawfish** added to total catch.

The average cost per northern **squawfish** in 1994 was \$4.68 and ranged **from** \$1.36 per northern squawfish at The **Fishery** to \$24.57 at **Umatilla**. The Fishery achieved the highest harvest (27,935 northern squawfish) and **Umatilla** the lowest (1,586 northern **squawfish**), which demonstrates how dramatically the cost per fish can be reduced by increasing the harvest per registration station.

The average cost per northern squawfish was highest in 1993 (\$10.62; **Appendix** Table G-3). The total **harvest** in 1993 was also lower than any other year. A cost comparison of registration stations from 1992-1994 showed the highest cost per northern squawfish came from **Umatilla** (\$24.57) **in** 1994, **Umatilla** (\$63.19) in 1993 and St. Helens (\$42.66) in 1992 (**Appendix** Table G-3). Variations in cost per northern **squawfish** by year and registration station occurred primarily due to (1) changes in northern **squawfish** harvest totals, (2) changes in the total number of registration stations, (3) equipment purchases, and (4) changes in the number of technicians used at registrations stations each year. The number of registration stations decreased from 20 in 1992 to 18 in 1992 and to 14 in 1994. The major costs for each registration station were **similar** regardless of the number of fish the station received, therefore stations with low harvest greatly increased the overall cost per fish. Registration station hours of operation in 1992 and 1993 were from 9 a.m. to 9 p.m. The hours of operation were decreased in 1994 to 1 p.m. to 9 p.m., which reduced technician hours and operation costs, but angler participation also dropped in 1994 to a level that was lower than any previous year. The reduction in hours of operation and the number of registration stations may have contributed to the decrease in participation.

The 1995 sport-reward fishery will expand the use of satellite stations to attract greater angler participation with minimal increases in cost. Satellite stations will be evaluated to determine if the additional fish were gained cost effectively.

References

Hanna, S., B. Anteneh, J. Pampush, M. Morrissey, D. Lin, and G. Foster. 1993. Economic, social, and legal **feasibility** of commercial, 'sport and bounty fisheries on northern squawfish. Report H *in* C.F. Willis, D.L. Ward, and A.A. Nigro, editors. Development of a **systemwide** predator control program: stepwise implementation of a predation **index**, predator control fisheries, and evaluation plan in the Columbia River Basin. 1992 Annual Report. Contract DE-B179-90BP07084, Bonneville Power **Administration**, Portland, Oregon.

Appendix Table G-3. Expenditure per northern squawfish > 11 inches by registration station for 1992, 1993 and 1994.

| Registration station | 1992 | 1993 | 1994 |
|----------------------------|---------------|----------------|---------------|
| Cathlamet | --- | 12.22 | 9.02 |
| Rainier | ---- | 44.02 | ---- |
| Kalama Marina | 10.25 | 43.25 | 13.10 |
| St. Helens | 42.66 | --- | ---- |
| Vancouver | 8.70 | - - | --- |
| M.J. Gleason | 4.61 | 7.88 | 4.55 |
| Camas/Washougal | ---- | 12.28 | 5.17 |
| Hamilton Island | 3.67 | 7.09 | 2.63 |
| The Fishery | 2.66 | 3.87 | 1.36 |
| Cascade Locks | 9.32 | 27.87 | |
| Bingen | 5.56 | 9.38 | 7.10 |
| The Dalles | 8.71 | 13.67 | 4.59 |
| LePage Park | 1.68 | 6.00 | |
| Maryhill State Park | 11.95 | ---- | --- |
| Giles French | --- | ---- | 3.35 |
| Plymouth | 26.32 | ---- | - - |
| Umatilla | --- | 63.19 | 24.57 |
| Columbia Point | 5.46 | 12.44 | 6.24 |
| Ringold | 9.93 | --- | |
| Vemita | ---- | 6.30 | 3.45 |
| Hood Park | 6.46 | 12.07 | 9.25 |
| Windust Park | 39.23 | --- | --- |
| Lyons Ferry State Park | 17.46 | 39.54 | ---- |
| Boyer Park | 10.60 | 46.30 | ---- |
| Greenbelt | 3.40 | 5.33 | 4.77 |
| AVERAGE PER YEAR | \$6.86 | \$10.62 | \$4.68 |

REPORT B

Northern Squawfish Sport-Reward Fishery Payments

Prepared by

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45 S.E. 82nd Dr., Suite 100, Gladstone, OR 97202**

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INTRODUCTION

The Pacific States Marine Fisheries Commission (**PSMFC**) provided fiscal services for payment of rewards for northern **squawfish** harvested under the sport-reward fishery. Anglers registered and subsequently checked-in their catch at the Washington Department of Fish and **Wildlife(WDFW)** field stations where they received a voucher for all eligible fish. Standard vouchers were issued for **all** fish over 11 inches that were not tagged. The number of fish turned in were recorded on the voucher and verified by the creel clerk. Tagged fish received a special “tagged” voucher. Tagged vouchers were issued for each individual tagged fish turned in. The vouchers were then sent by the angler to our sport-reward post office box in Oregon City. Vouchers were received and paid during the fishery from May through September. A cut-off date of September 25, 1994, was established as the **final** date vouchers needed to be postmarked to receive payment **from PSMFC**. These dates were printed in bold on the vouchers. PSMFC allowed one month past the official cut-off date for receipt of the vouchers, then started rejecting late vouchers because of logistics and the need for Internal Revenue Service (IRS) reporting for the calendar year. Tagged vouchers were sent to the Oregon Department of Fish and **Wildlife** post office box by the angler for verification. The angler attached the tag to the voucher in a small envelope provided at the check station. Once verified or rejected by Oregon Department of Fish and Wildlife, all tag vouchers were delivered to PSMFC for payment. Verified tagged vouchers were paid at **\$50** per tag and rejected tagged vouchers were paid at the standard reward of **\$3**. The following sections summarize the vouchers paid this year.

VOUCHER PAYMENTS

A total of 13,434 vouchers were processed and paid during the 1994 fishing season. They represented 127,531 fish and a total reward payment sum of \$396,364. Of this total, 13,141 were “standard” vouchers representing 127,238 fish (\$38 1,714). A total of 293 tagged vouchers was received for the 293 tagged fish caught. The payments for these fish totaled \$14,650. Of **all** vouchers received, 93 vouchers for 242 fish (\$726) remain unpaid. Rejected vouchers are addressed in a later section of this report. Table 1 displays the breakdown of the 13,434 vouchers processed.

Voucher processing proceeded smoothly. Depending on volume received, checks were cut and mailed to the angler within 5 days of receipt of the voucher. Those vouchers that had missing or incomplete **information** were returned to the angler for **completion**, or to WDFW, as appropriate.

Table 1. Breakdown of the 13,434 vouchers processed in 1994.

| # Vouchers | Voucher type | # Fish | \$ Value | Mean fish/voucher |
|----------------|--------------|---------|-----------|-------------------|
| Standard (\$3) | 13,141 | 127,238 | \$381,714 | 9.68 |
| Tagged (\$50) | 293 | 293 | \$14,650 | N/A |

REJECTED VOUCHERS/ MISCELLANEOUS PAYMENTS

Rejected vouchers represent vouchers that had missing data and were returned to the angler, but the angler chose not to complete them and send them back for payment. Therefore, these vouchers were not paid. The breakdown of rejected vouchers returned to the angler by reason for initial or subsequent submission is displayed in Table 2.

In addition to the voucher payments, a number of tournaments, drawings and prizes were awarded during the season. The amounts paid out for all parts of the program during 1994 are displayed in Table 3

Table 2. Breakdown of rejected vouchers in 1994.

| Reason for rejection | # Vouchers | # Fish |
|--|------------|--------|
| Questionnaire not completed | 64 | 180 |
| Social Security # missing | 12 | 20 |
| Questionnaire not completed twice ¹ | 6 | 11 |
| No angler signature | 4 | 7 |
| Submitted past deadline | 7 | 24 |
| Total | 93 | 242 |

¹ Vouchers returned twice for missing questionnaire.

Table 3. Amounts paid out for the 1994 sport-reward **fishery**.

| Program type | \$ Paid |
|---|------------------|
| Standard vouchers | \$381,714 |
| Tagged fish vouchers | 14,650 |
| Weekly tournaments (246 prizes) | 20,500 |
| Monthly drawings (25 prizes) | 10,000 |
| Special tag drawings (2 prizes) | 10,000 |
| G.I. Joe tournaments (24 prizes) | 5,000 |
| Upper river tournaments (24 prizes) | 4,000 |
| Total | \$445,864 |

Lists of the top **25** anglers with their name, address, standard and tag voucher payments, prize, tournament and drawings winnings were provided to the technical coordinator and Bonneville Power Administration.

MISCELLANEOUS WORK

All IRS Form 1099-Mist. statements were sent to the **qualifying** anglers for tax purposes the third week in January. Appropriate reports and copies were provided to the IRS by the end of February.

The last quarter of the current contract period work has centered on cleaning up the voucher data entry program and associated accounting cross-checks, reports and voucher tracking and editing routines. The program has become more sophisticated to allow nearly all options necessary by means of program menus without the need for special programming expense or computer program technical time. We now have the option to look at previous years' data and to **carry** forward certain files and angler data to shorten data **entry** time. We have also added the ability to carry forward suspense vouchers and those rejected or on hold, should they clear in the **future** for payment. Recent additions also allow for the **carry** forward of IRS or other agency garnishments that extend across two or more fishing seasons (years).

REPORT C

Controlled Angling for Northern Squawfish at Selected Dams on the Columbia and Snake Rivers

Prepared by

Columbia River Inter-Tribal **Fish Commission
729 N.E. Oregon, Suite 200, Portland, OR 97232**

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ACKNOWLEDGMENTS

We thank Silas Whitman and Manuel **Villalobos** (**Nez Perce** Tribe); Gary James and Jed **Volkman** (Confederated Tribes of the **Umatilla** Indian Reservation); Lynn Hatcher, Steve Parker, and George Lee (Confederated Tribes and Bands of the **Yakama** Indian Nation); and **Jim** Griggs and Mark **Fritsch** (Confederated Tribes of the Warm Springs Reservation of Oregon) for implementing the work performed by tribal crews. Our deep appreciation goes to the technicians working for the Columbia River Inter-Tribal Fish Commission and tribal crews who **fulfilled** their duties admirably.

Personnel from the U.S. Army Corps of Engineers were invaluable in their cooperation and coordination: Jim **Kuskie** and Dennis Schwartz (Bonneville Dam); Jim Williams and Bob Dach (The **Dalles** and John Day dams); Peter Gibson and Brad Eby (**McNary** Dam); Bill Spurgeon (Ice Harbor and Lower Monumental dams); Rex Baxter and Rebecca **Kalamasz** (Little Goose Dam); and Jesse **Smiley**, Tim **Wik**, Mike Halter, and Ron Robson (Lower Granite Dam).

We give special thanks to the volunteer anglers from the Portland and Tom McCall chapters of Northwest **Steelheaders**, The **Dalles** Rod and Gun Club, and Mid-Columbia Bass Anglers, who have contributed to our efforts for two or more years.

Roy **Beaty**, Ken **Collis**, Jack **McCormack**, and Kathy **McRae** (alphabetical order) contributed to this report. We thank **Blaine** Parker, Keith **Hatch**, Dave Ward, Chris **Knutsen**, Mark **Zimmerman**, and Frank Young for their comments on an earlier draft of this **report**.

ABSTRACT

The 1994 field crews used hook-and-line angling for northern **squawfish** (*Ptychocheilus oregonensis*) at eight lower **mainstem** dams of the Columbia and Snake rivers from early May through early September. Total catch (16,097 fish) was 95% of the 1993 catch. Total **effort** (10,002 hours) was approximately 3% higher than in 1993. Yearly catch-per-angler-hour (CPM-I) has remained relatively constant for the last three years (1992: 1.7; 1993: 1.7; 1994: 1.6). On the Columbia River, catch rates decreased at Bonneville, John Day, and McNary dams and increased at The **Dalles** Dam compared to 1993. Because of continued low catch rates, effort on the Snake River was reduced 43% from 1993 levels. However, the 1994 CPAH on the Snake River increased slightly compared to 1993.

As in past years, effort was focused at the most productive dams, and resident-crew effort was supplemented by volunteer, boat, and mobile **angling**. Four sport-angling groups donated their time at Bonneville, The **Dalles**, and **McNary** dams. The volunteers contributed 3.2% of the total catch. Most (**83%**) of boat-angling effort was spent at John Day and **McNary** dams with the

remainder at The Dalles, Ice Harbor, and Lower Monumental dams. Boat anglers contributed 7.7% of the total effort and caught 3.2% of the total northern **squawfish**. The mobile angling crew fished at Bonneville, The Dalles, and John Day dams, which yielded **24.8%** of the total catch and a CPAH of **2.8**.

Incidental catch in 1994 comprised 2.3% of the total catch -- less than half of that in 1993 (5.5%). Almost half of the incidental catch was bass (*Micropterus* spp.), and white sturgeon (*Acipenser transmontanus*) made up another **20%**. There were 12 incidentally caught salmonids (*Oncorhynchus* spp.), all of which were juveniles; nine were released in good condition, two in poor condition, and one died.

Catch rates of northern **squawfish** were compared to outflow, smelt passage indices, and for different anglers, time periods, baits, and sites at each dam. These results are briefly discussed and were used in developing recommendations for **future** dam-angling activities.

INTRODUCTION

The eight hydroelectric dams on the lower Columbia and Snake rivers have converted a once free-flowing river into a series of reservoirs that prolong the seaward migration of juvenile salmonids (*Oncorhynchus* spp). The reservoir environment provides **predatory** fish with conditions more suitable for feeding, especially near dams (Raymond 1979; Rieman et al. 1991). A principal predator, northern **squawfish** (*Ptychocheilus oregonensis*), has been targeted for control in the lower Columbia and Snake rivers by a multi-agency program aimed at reducing juvenile **salmonid** mortality due to northern **squawfish** predation. Northern **squawfish** can be effectively removed from the dams using hook-and-line angling techniques (Vigg et al. 1990; Beaty et al. 1993; Parker et al. 1993; CRITFC 1995). From 1990 to 1993, **angling** crews caught a total of 95,173 northern **squawfish** at eight dams on the lower Columbia and Snake rivers. In 1994, as in previous years, the Columbia River Inter-Tribal Fish Commission (CRITFC) and its member tribes endeavored to (1) remove northern squawfish from areas near dams; (2) minimize the incidental catch, particularly of **salmonids** and white sturgeon (*Acipenser transmontanus*); and (3) develop and implement more effective means of removing northern squawfish.

METHODS

Management Activities

In 1994, effort by angling crews was distributed among eight U.S. Army Corps of Engineer (USACE) dams on the Columbia and Snake rivers (Table 1 and Figure 1). Most of this year's effort was focused at Columbia River dams, where catch rates in previous years have been consistently higher. Snake River dams were fished by a single crew that spent a majority of its time at Lower Granite and Little Goose dams. **McNary** Dam was fished by two crews who distributed their effort over seven days per week.

Table 1. **Distribution of angling effort for resident crews at Columbia and Snake River dams in 1994.**

| Dam (river km) | Season | Number of days worked | crew supervised by ^a |
|------------------------------|------------------------|-----------------------|---------------------------------|
| <u>COLUMBIA RIVER</u> | | | |
| Bonneville (233) | May 31- Sept 1 | 52 | CTws |
| The Dalles (310) | May 9 - Aug 31 | 67 | CTws |
| John Day (348) | June 14- Sept 6 | 40 | YIN |
| McNary (470) | June 2 - Aug 31 | 89 | CTUIR |
| <u>SNAKE RIVER</u> | | | |
| Ice Harbor (16) | Aug 15- Aug 31 | 7 | NPT |
| Lower Monumental (68) | Aug 8- Aug 10 | 3 | NPT |
| Little Goose (113) | June 7- July 28 | 11 | NPT |
| Lower Granite (172) | May 23- Aug 30 | 33 | NPT |

- ^a CTWS = Confederated Tribes of Warm Springs Reservation
 YIN = Yakama Indian Nation
 CTUIR = Confederated Tribes of Umatilla Indian Reservation
 NPT = Nez Perce Tribe

Volunteer crews, boat-angling crews, and a mobile crew augmented effort at selected dams (Table 2). Volunteer anglers from four sport-angling groups were supervised by members of the **mobile** crew and fished at Bonneville, The **Dalles**, and **McNary** dams (Table 2). Members of resident crews at The **Dalles**, John Day, McNary, Ice Harbor, and Lower Monumental dams conducted boat angling, which was confined to **tailrace** boat restricted zones (**BRZ**). The **mobile**

crew fished at Columbia River dams when and where catch rates were **high**, and also contributed to boat-angling effort at John Day Dam.

Table 2. Supplemental angling activities used in 1994.

| Supplemental angling method & personnel | Dam | Dates |
|--|---|---|
| <u>MOBILE CREW</u> | | |
| CRITFC | Bonneville, The Dalles, & John Day | June 1 - Sept 8 (59 days total) |
| <u>VOLUNTEER ANGLING</u> | | |
| Mid-Columbia Bass Anglers | McNary | June 17, 24; July 1,8, 15,22, 29; August 12 |
| The Dalles Rod & Gun Club | The Dalles | June 23, 30; July 7,14,21,28 |
| Portland Chapter - NW Steelheaders | Bonneville | June 25; July 16, 30; August 13,27 |
| Tom McCall Chapter - NW Steelheaders | Bonneville | July 9,23 |
| <u>BOAT ANGLING</u> | | |
| CRITFC | John Day | August 17,24 |
| YIN | The Dalles | June 30 |
| | John Day | June 29, 30; July 13, 14,21, 22; August 16, 17, 18,22,23,24,30 |
| NPT | Ice Harbor | August 15-18,22,23 |
| | Lower Monumental | August 8,9, 10 |
| CTUIR | McNary | June 30; July 4,5, 12, 13,18-21, 24,26,27, 31; August 1,19,21-31 |

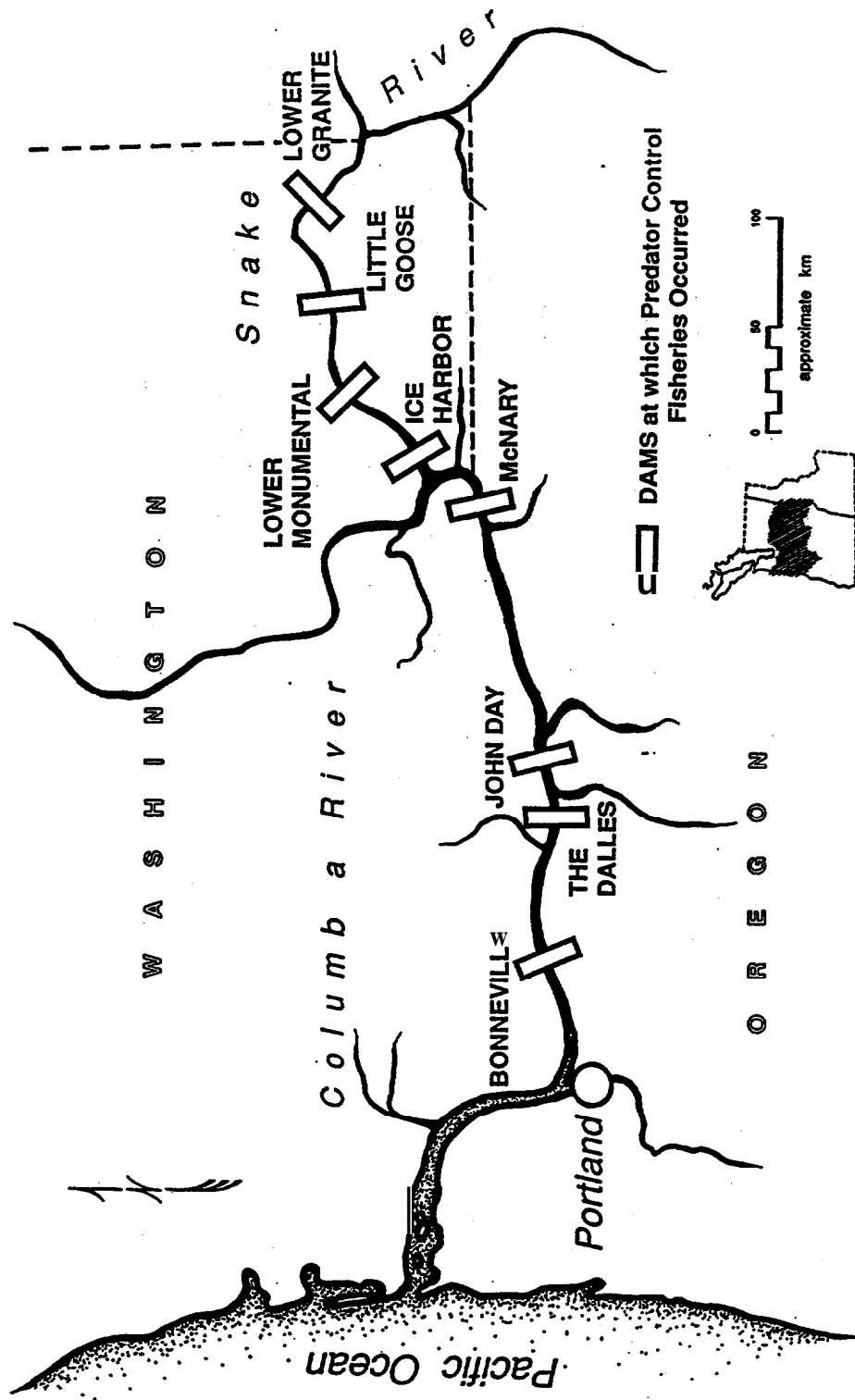


Figure 1. Dams where controlled angling operations were conducted in 1994.

Angling Methods

Anglers' equipment and techniques, including measures to minimize incidental **catch**, were similar to those used in the previous two years (see Parker et al. 1993). Once identified, **all salmonids ≥ 0.50 m and sturgeon ≥ 0.75 m** were immediately cut free to minimize stress and injury. Smaller salmon and sturgeon and all other species incidentally caught were **reeled in**, unhooked, and released immediately. In most cases, bronzed de-barbed hooks were used with a variety of baits (see Parker et al. 1993 for bait descriptions).

Data Collection and Analysis

As in previous years, data were collected using hand-held computers and transmitted daily via modem to **CRITFC's** Portland office (see Parker et al. 1993). Atypical data were identified using custom computer programs, then investigated and corrected **if necessary**. Weekly summary reports of catch and effort at each dam were provided to the Oregon Department of Fish and Wildlife (**ODFW**) via the Columbia Basin Fish and **Wildlife** Authority (**CBFWA**) bulletin board system (BBS).

Dam outflow and juvenile fish passage data were provided by the Fish Passage Center (**FPC**). Because daily values varied greatly, plots of CPAH on dam **outflow** and smelt passage indices are progressive averages for all variables. Progressive averages are calculated from the most current seven days' values.

RESULTS AND DISCUSSION

Northern Squawfish Catch

Spatial Effects

Anglers in 1994 caught 16,097 northern squaw-fish in 10,002 h of fishing, for an annual catch per angler hour (**CPAH**) of 1.6. **Angling** crews at Columbia River dams caught 15,270 northern squaw-fish in 8,911 h of effort for an overall **CPAH** of 1.7. Anglers at Snake River dams captured 827 northern **squawfish in** 1,092 h of effort, resulting in a CPAH of 0.8 (Table 3).

Table 3. Northern squawfish (NSF) catch, angling effort, and catch-per-angler hour (CPM) by dam for 1991, 1992, 1993, and 1994.

| Dam | 1991 | | | 1992 | | | 1993 | | | |
|------------------------------|---------------|--------------|------------|--------------|------------|------------|--------------|--------------|------|---------------|
| | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF |
| <u>COLUMBIA RIVER</u> | | | | | | | | | | |
| Bonneville | 8,131 | 2,621 | 3.1 | 4,814 | 1,781 | 2.7 | 5,836 | 1,991 | 2.9 | 5,238 |
| The Dalles | 3,674 | 1,333 | 2.8 | 7,561 | 2,496 | 3.0 | 2,712 | 1,992 | 1.4 | 4,393 |
| John Day | 5,004 | 2,816 | 1.8 | 3,427 | 2,775 | 1.2 | 2,248 | 1,044 | 2.2 | 3,083 |
| McNary | 8,348 | 3,416 | 2.4 | 7,297 | 2,523 | 2.9 | 5,148 | 2,780 | 1.9 | 2,556 |
| Season | 25,157 | 10,187 | 2.5 | 23,099 | 9,575 | 2.4 | 15,944 | 7,807 | 2.0 | 15,270 |
| <u>SNAKE RIVER</u> | | | | | | | | | | |
| Ice Harbor | 1,486 | 2,052 | 0.7 | 278 | 298 | 0.9 | 122 | 404 | 0.3 | 23 |
| Lower Monumental | 3,313 | 2,472 | 1.3 | 475 | 943 | 0.5 | 105 | 396 | 0.3 | 27 |
| Little Goose | 4,915 | 2,140 | 2.3 | 1,664 | 3,062 | 0.5 | 100 | 378 | 0.3 | 92 |
| Lower Granite | 4,480 | 2,448 | 1.8 | 2,352 | 2,881 | 0.8 | 678 | 734 | 0.9 | 685 |
| Season | 14,194 | 9,112 | 1.6 | 4,769 | 7,184 | 0.7 | 1,005 | 1,911 | 0.5 | 827 |
| TOTALS | 39,351 | 19,298 | 2.0 | 27,868 | 16,759 | 1.7 | 16,949 | 9,718 | 1.7 | 16,097 |

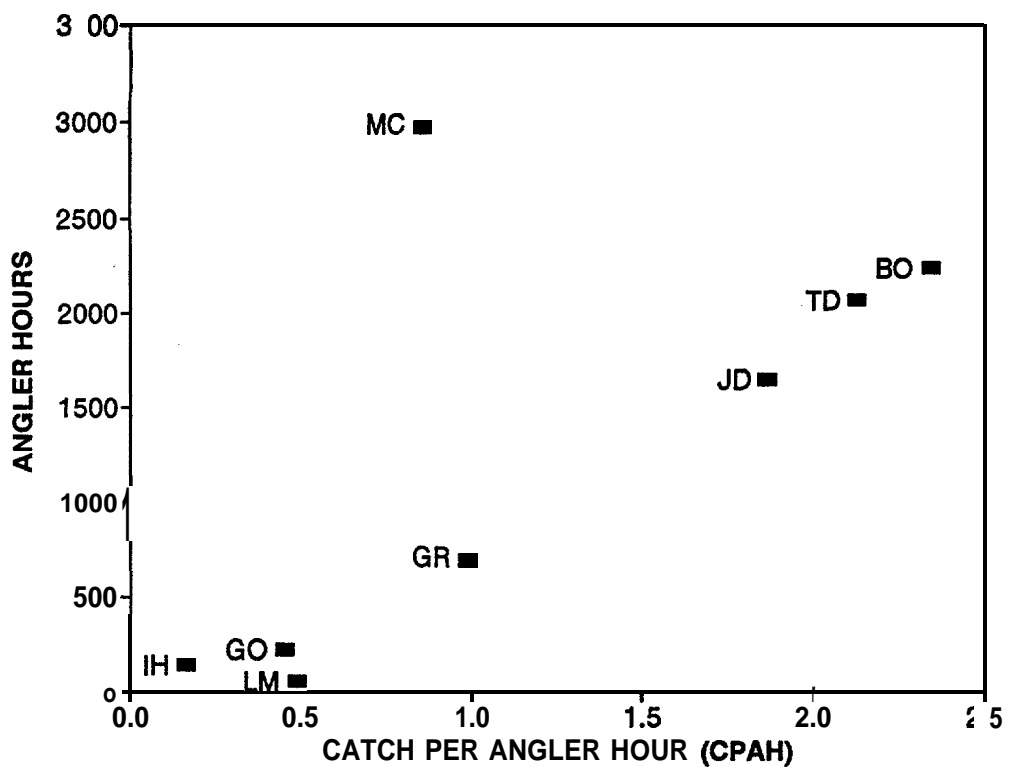


Figure 2. Annual catch per angler hour (CPAH) and total hours fished, by dam for 1994.

Among Columbia River dams, the largest catch (5,238) and CPAH (2.3) were at Bonneville **Dam**, followed by The **Dalles**, John Day, and McNary dams (Table 3). The greatest amount of effort (2,966 h) was expended at **McNary** Dam based on high catch rates in previous years. This year, however, catch rates at **McNary** Dam did not warrant this level of effort (Figure 2). On the Snake River, Lower Granite Dam had the largest catch and highest **CPAH**, as was the case in previous years (Table 3).

Catch rates and percent of total catch of northern **squawfish** at various sites were highest in **tailrace** areas at most dams (**Figures** 3 through 10). **Sites** fished fewer than 10 angler-hours or contributing less than 1% of the total northern squawfish catch are not shown on maps.

Temporal Effects

Total catch (16,097 fish) for the 1994 season was 95% of the 1993 **catch**, and total effort (10,002 h) was approximately 3% higher than in 1993 (Table 3). Yearly CPAHS for dam angling have remained relatively constant for the last three years, as has **effort** for the last two years (Table 3).

On the Columbia River, northern **squawfish** catch (15,270 fish) was 96% of the 1993 **catch**, despite a 14% increase in effort in 1994 (Table 3). The **annual** CPAH at Columbia River dams has continued to decline since 1991 (Table 3). The catch at Snake River dams was 82% of that in 1993, with 57% of the annual effort. Annual CPAH at Snake River dams was higher in 1994 (0.8) than in 1993 (0.5).

In 1994, catch rates declined at three of the four Columbia River dams (Bonneville, John Day, and **McNary**; Table 3), as compared to 1993. The greatest decline occurred at McNary dam (1993 **CPAH**: 1.9; 1994 CPAH: 0.9), which maybe explained by changes in flow at McNary Dam from previous years (**B.** Eby, USACE, personal communication). Conversely, CPAHS at Snake River dams increased at three out of four dams (Lower Monumental, Little Goose, and Lower Granite) this year as compared to last year (Table 3). The catch rate at Ice Harbor declined slightly **from** 1993. The significance of these changes is uncertain due to low levels of effort at these dams.

As in previous years, northern **squawfish** catch and CPAH at Columbia River dams were highest in July (**Figures** 11 and 12). Patterns in monthly catch and CPAH are less obvious at Snake River dams. However, peaks in catch and catch rate seemed to occur **earlier** in the year as compared to Columbia River dams (Figures 11 and 12).

Weekly totals of **catch**, effort, and CPAH for 1994 are listed in Appendix Tables A-1 and A-2. Plots of weekly CPAHS for 1994 indicate that an earlier start at the **Dalles**, **McNary**, and Lower Granite dams may have been productive (Figures 13 and 14).

Although differences among individual dams were apparent, the highest CPAH for both river systems was during the 1801-2400 hours time period (Table 4).

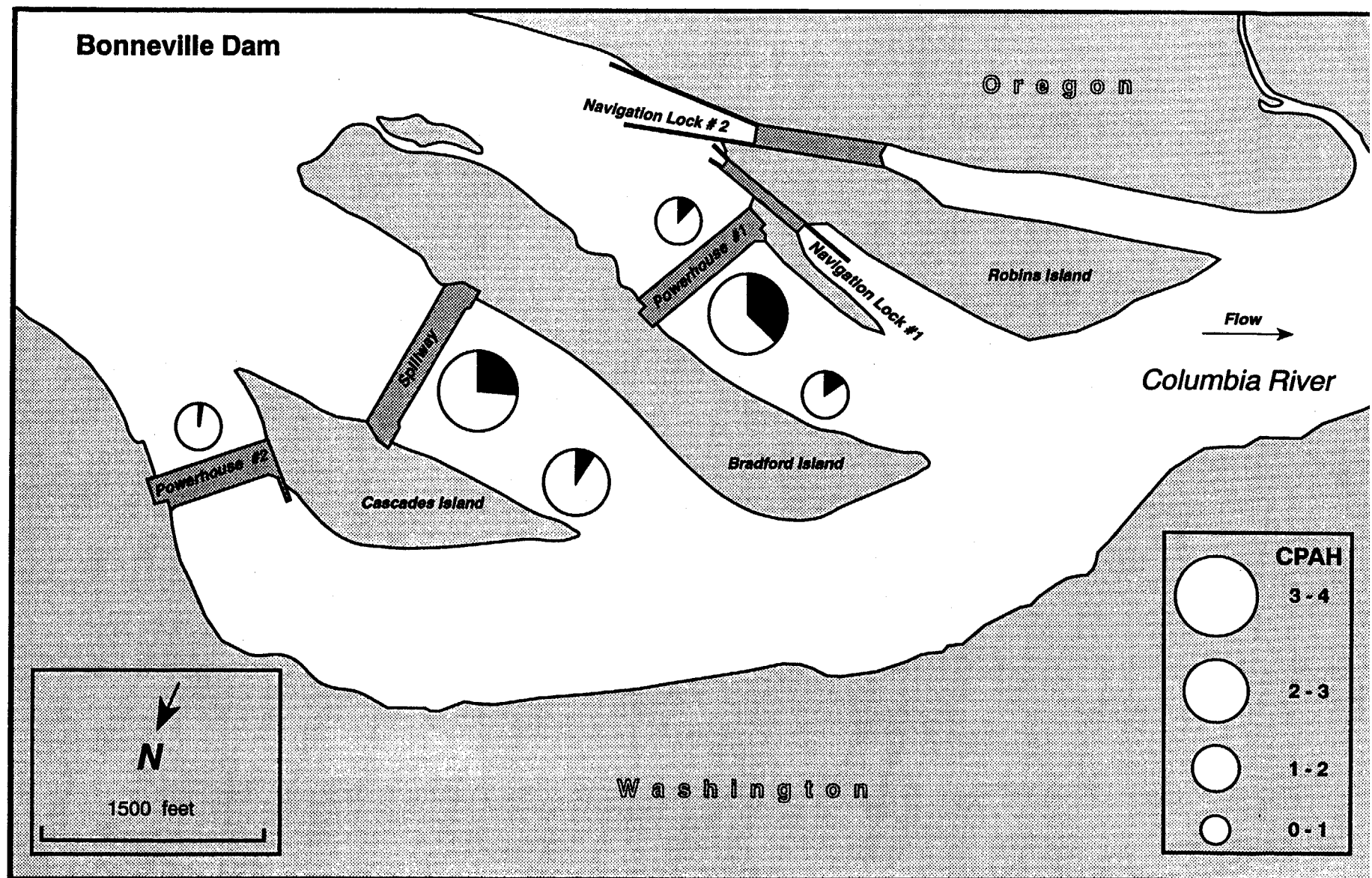


Figure 3 . Catch-per-angler-hour (CPAH) of northern squawfish in various sites at Bonneville Dam, 1994. Dark shading in circles represents the percent of total catch caught at that site.

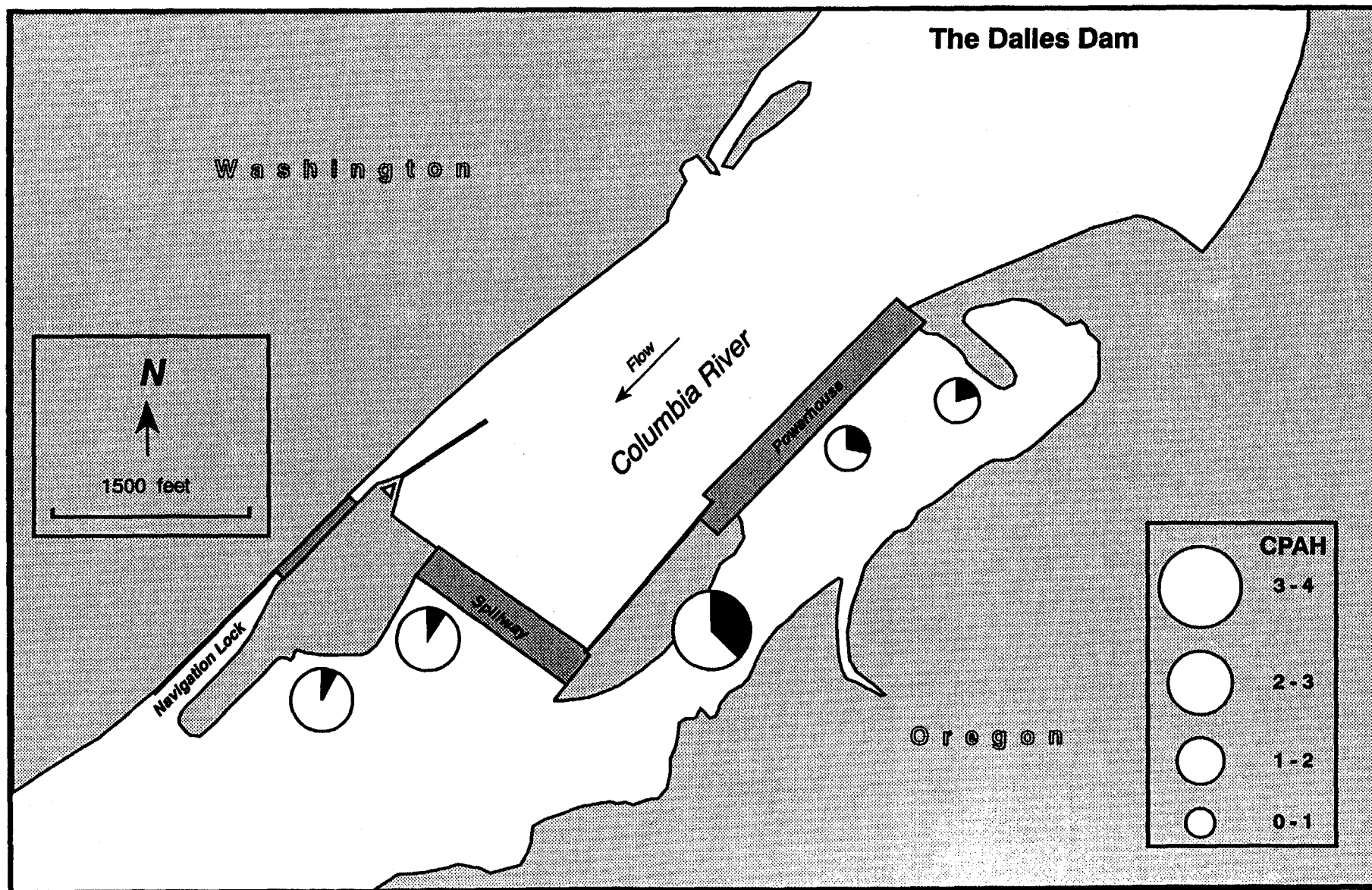


Figure 4. Catch-per-angler-hour (CPAH) of northern squawfish in various sites at The Dalles Dam, 1994. Dark shading in circles represents the percent of total catch caught at that site.

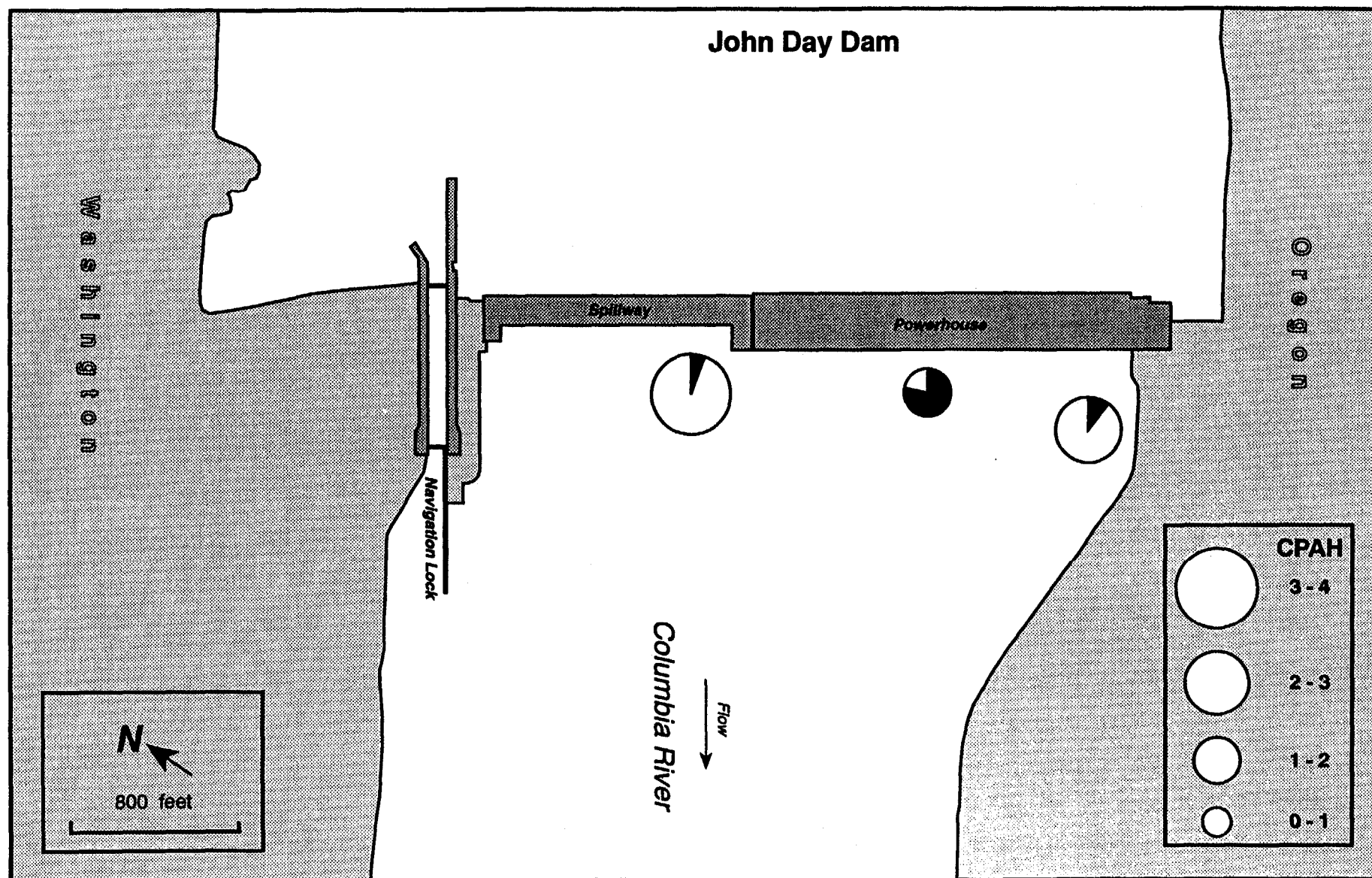


Figure 5. Catch-per-angler-hour (CPAH) of northern squawfish in various sites at John Day Dam, 1994. Dark shading in circles represents the percent of total catch caught at that site.

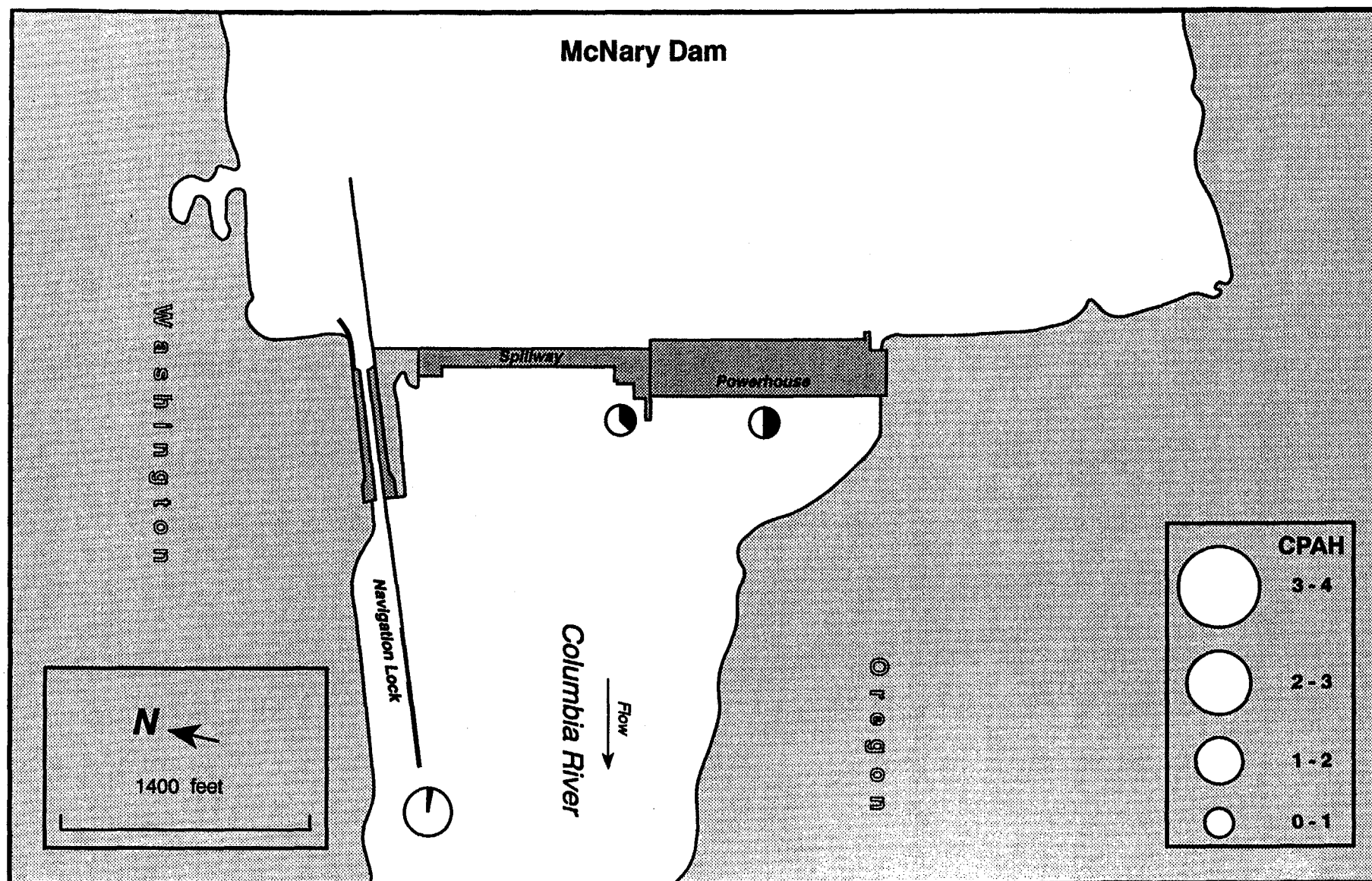


Figure 6. Catch-per-angler-hour (CPAH) of northern squawfish in various sites at McNary Dam, 1994. Dark shading in circles represents the percent of total catch caught at that site.

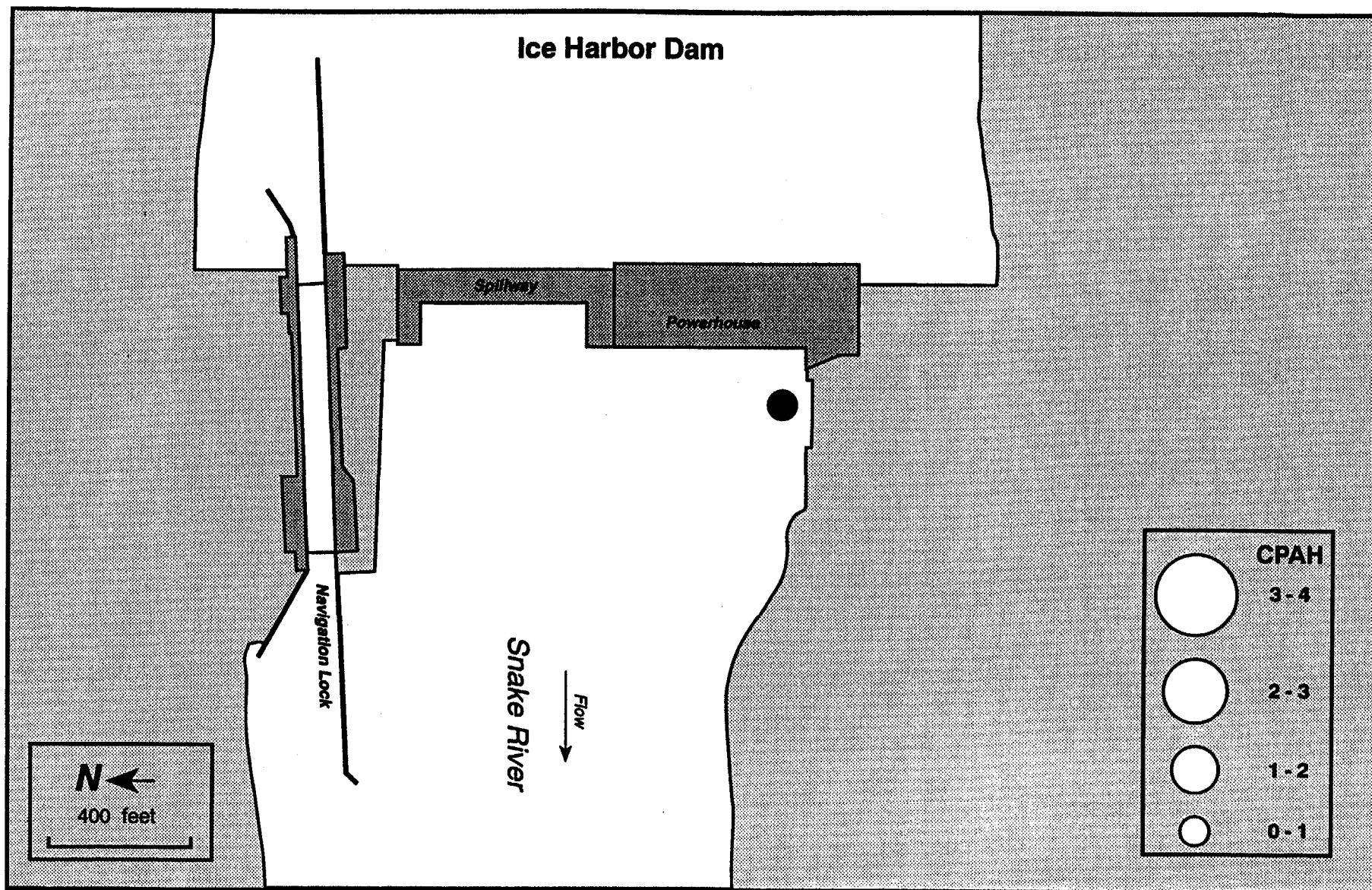


Figure 7 . Catch-per-angler-hour (CPAH) of northern squawfish in various sites at Ice Harbor Dam, 1994. Dark shading in circles represents the percent of total catch caught at that site.

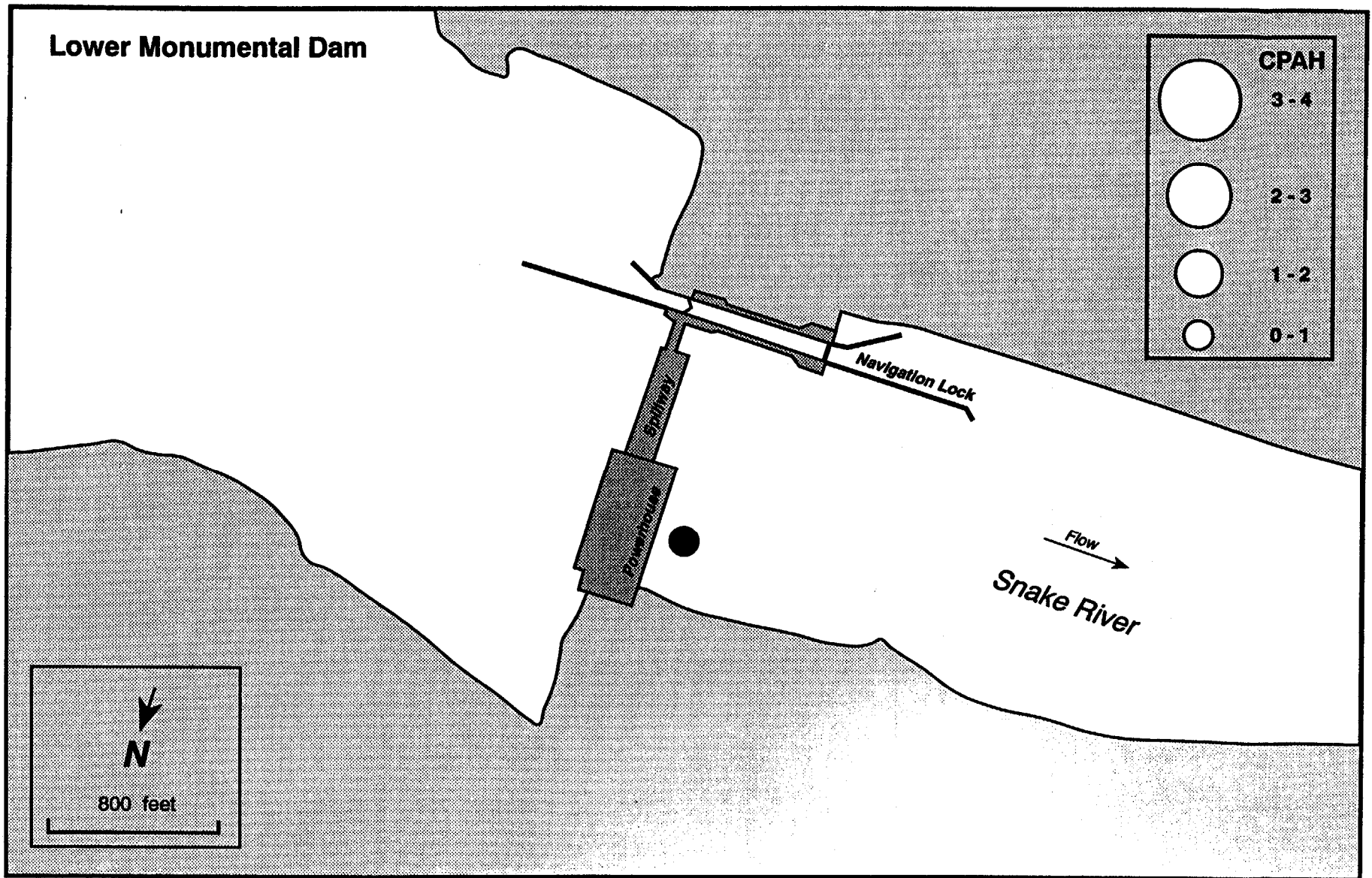


Figure 8 . Catch-per-angler-hour (CPAH) of northern **squawfish** in various **sites** at Lower Monumental Dam, 1994. Dark shading **in** circles represents the percent **of** total catch caught at that site.

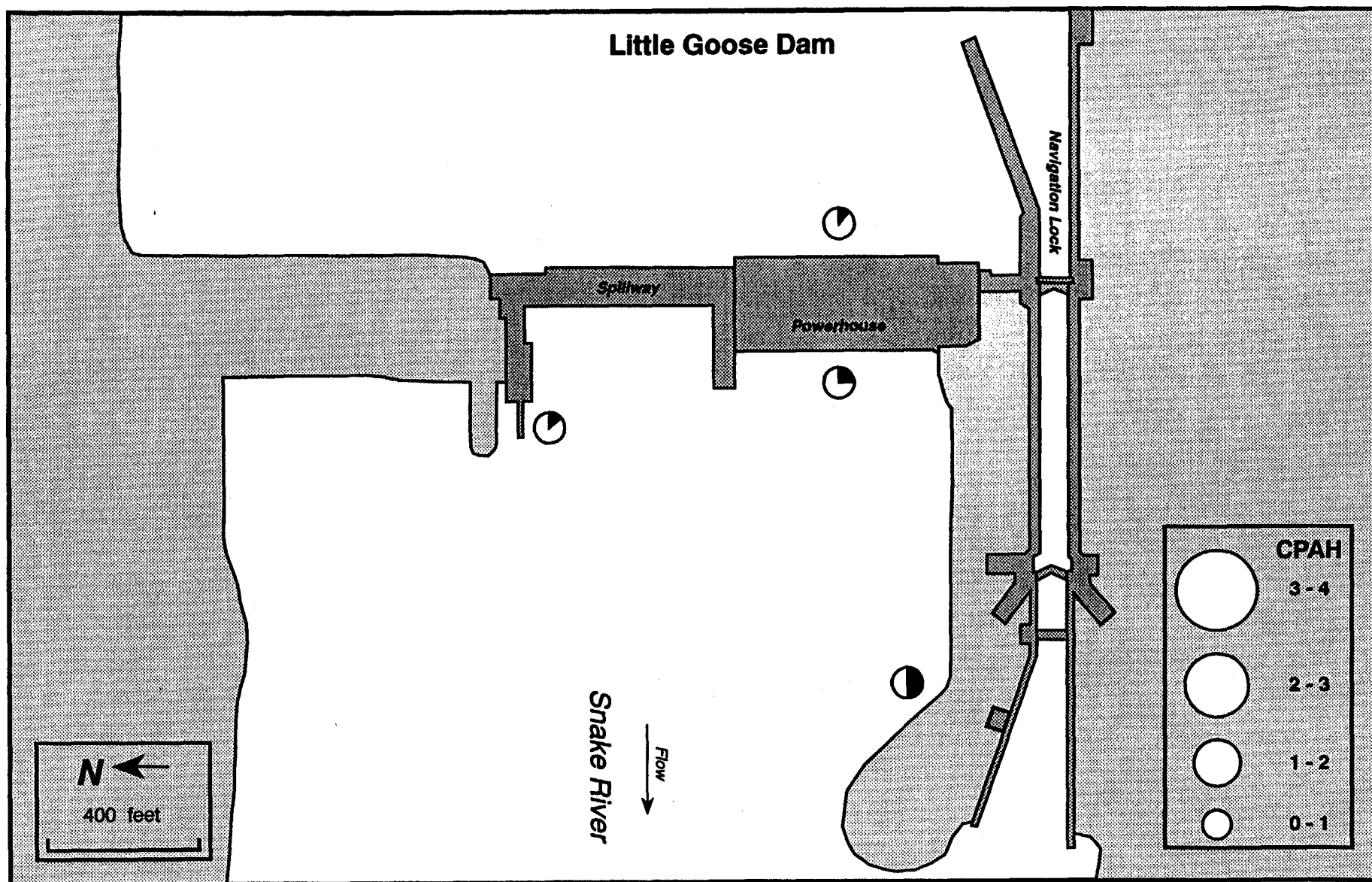
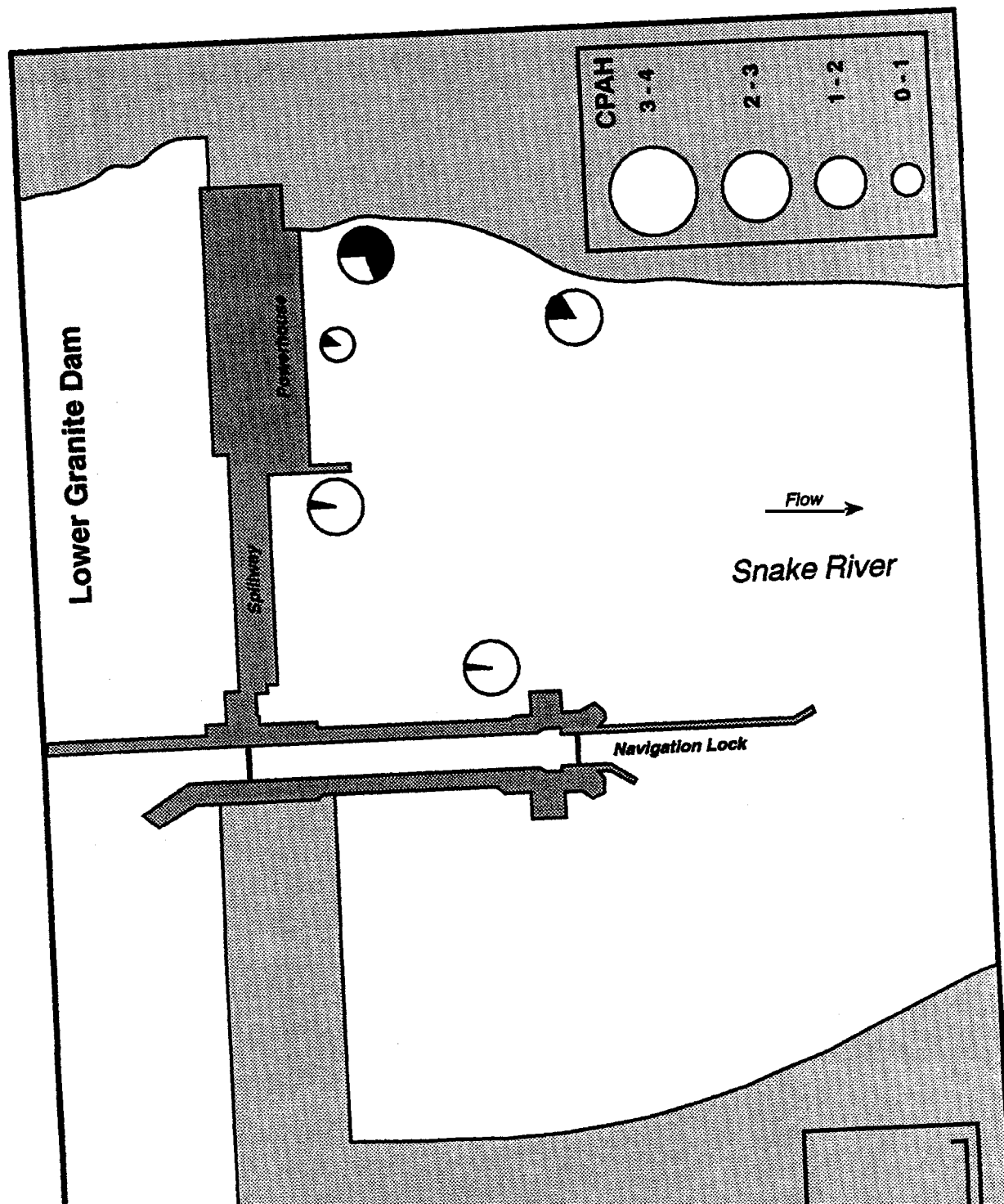
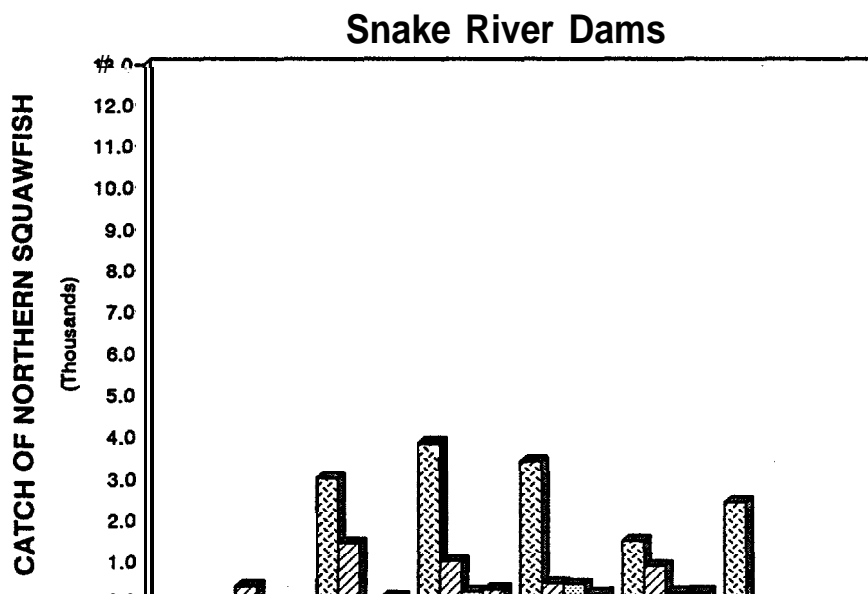
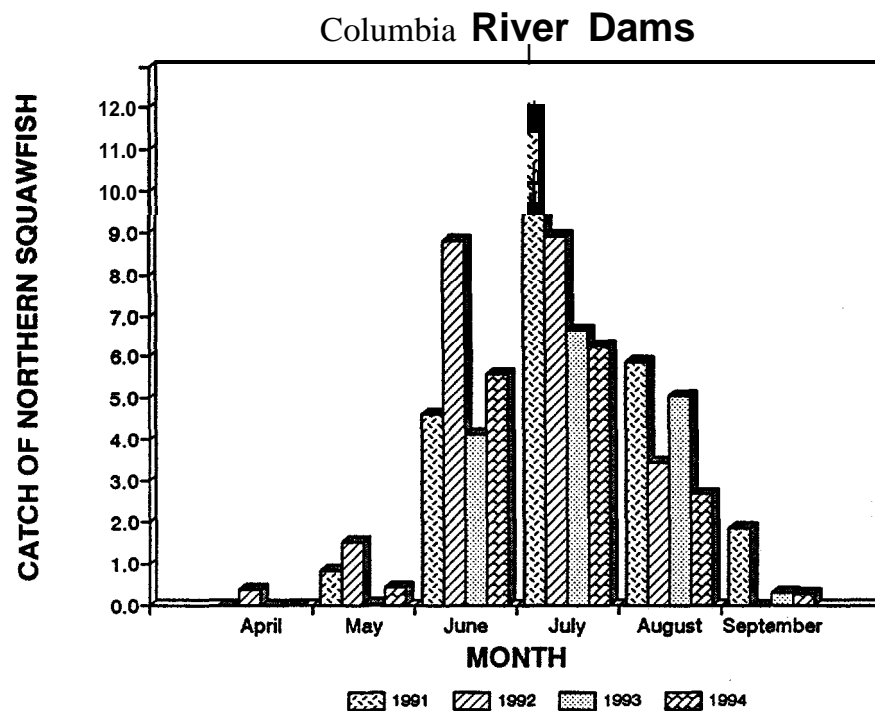


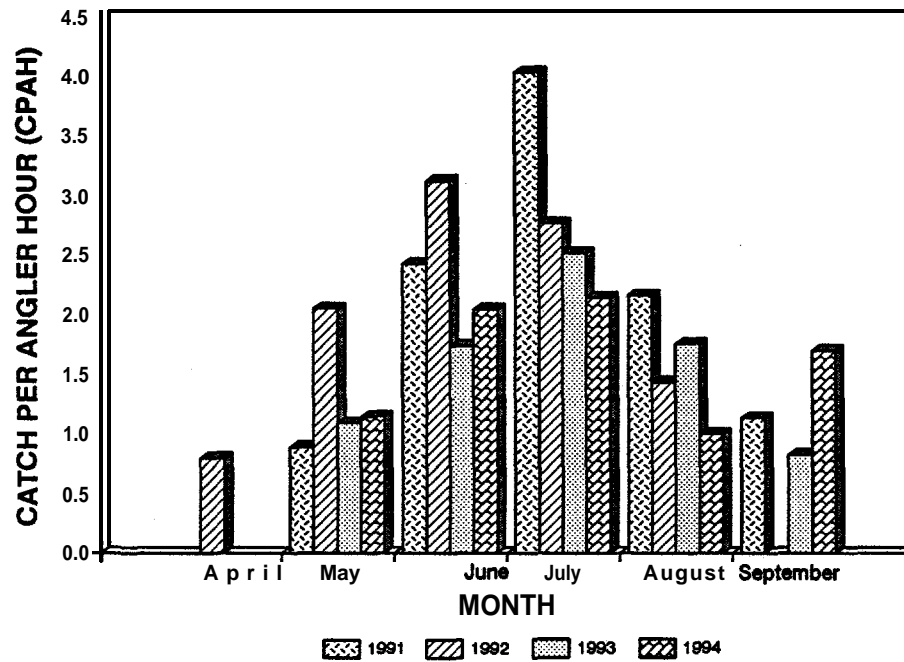
Figure 9. Catch-per-angler-hour (CPAH) of northern squawfish in various sites at **Little** Goose Dam, 1994. Dark shading **in** circles represents the percent of total catch caught at that site.



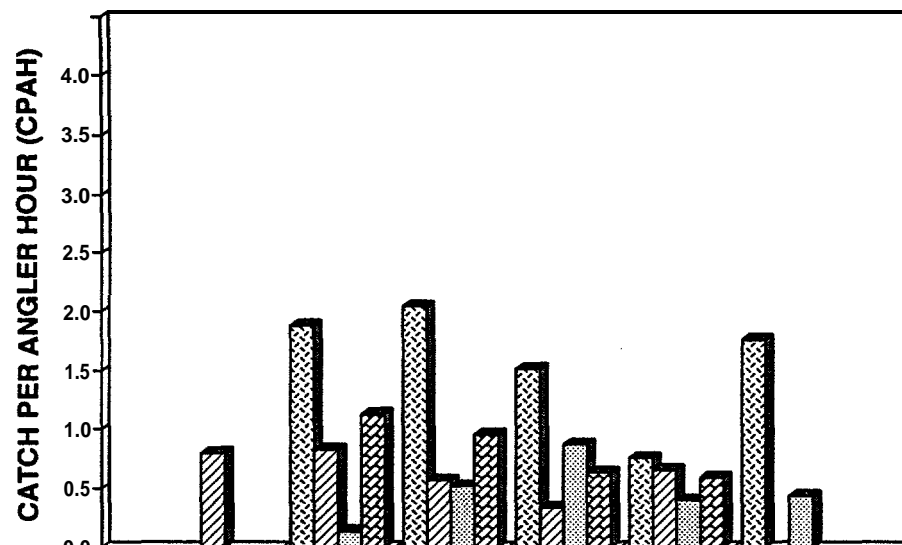
h-per-angler-hour (CPAH) of northern squawfish in various sites at Lower
Dark shading in circles represents the percent of total catch caught at



Columbia River Dams



Snake River Dams



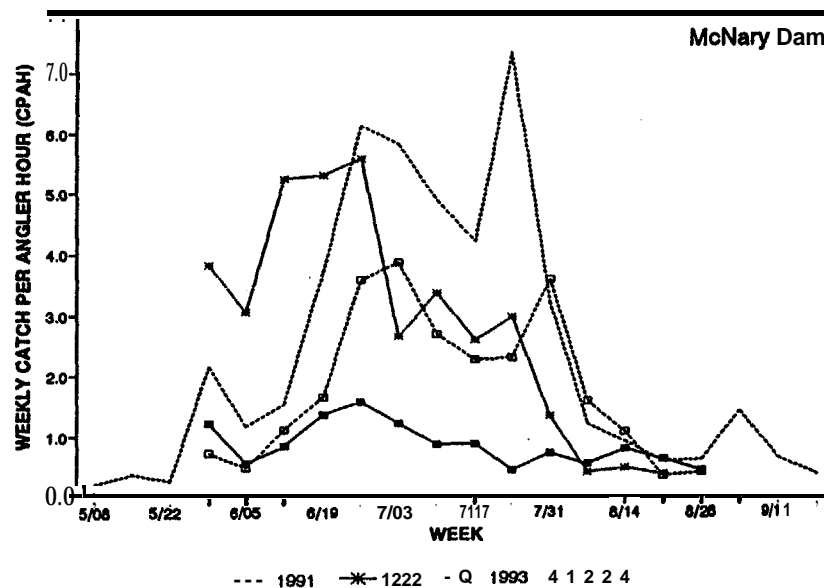
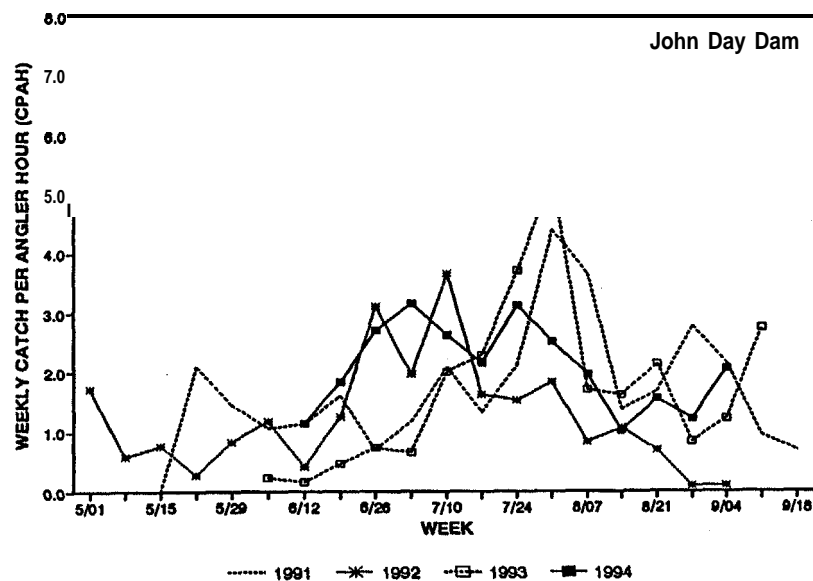
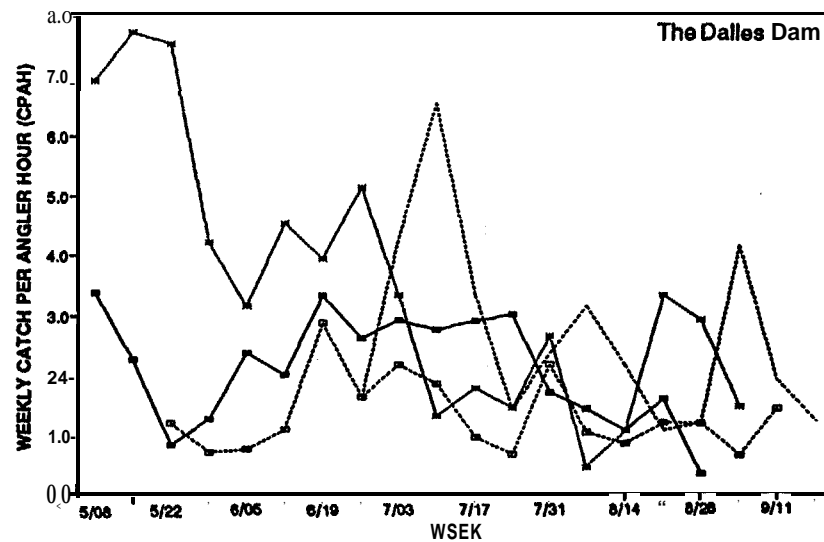
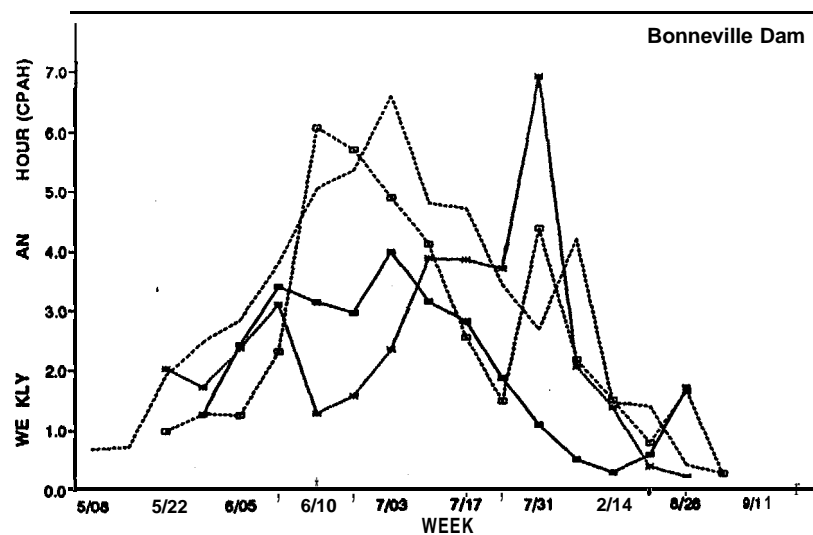


Figure 13. Weekly average catch per angler hour (CPAH) at Columbia River dams, 1991 through 1994.

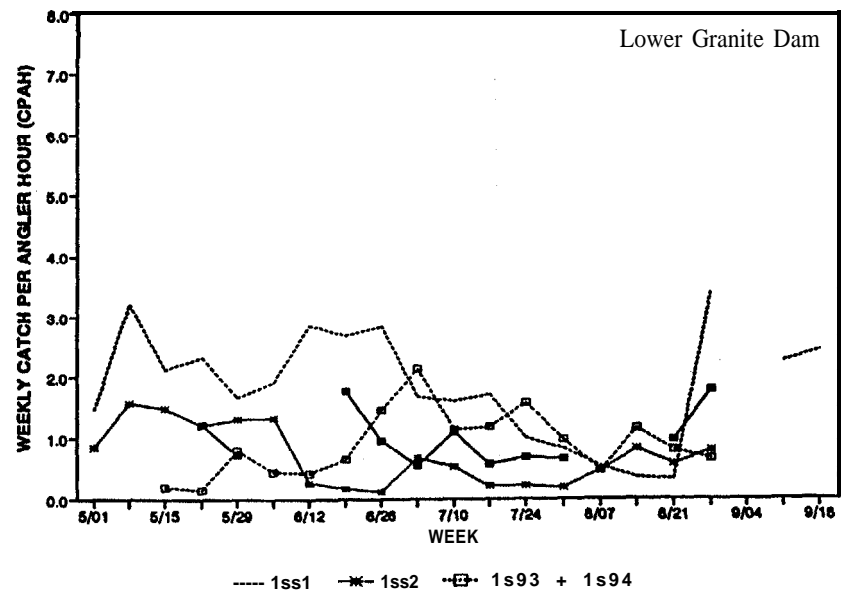
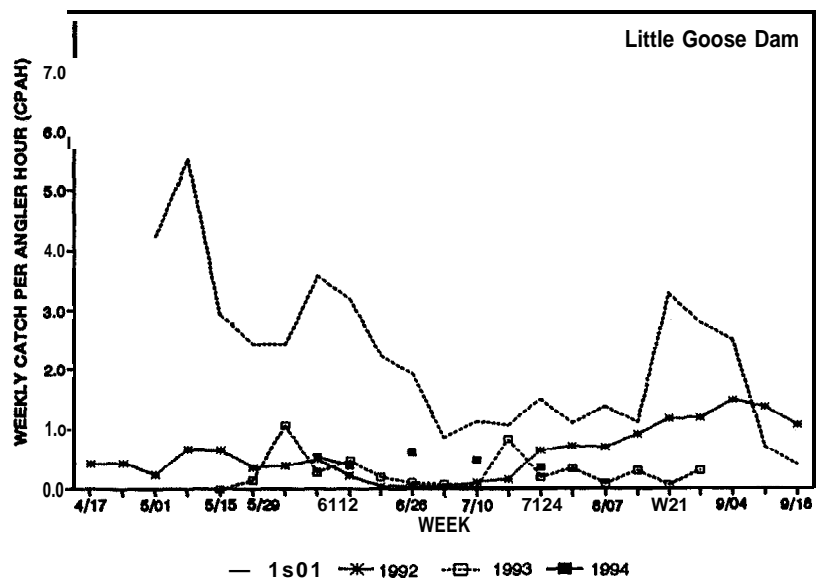
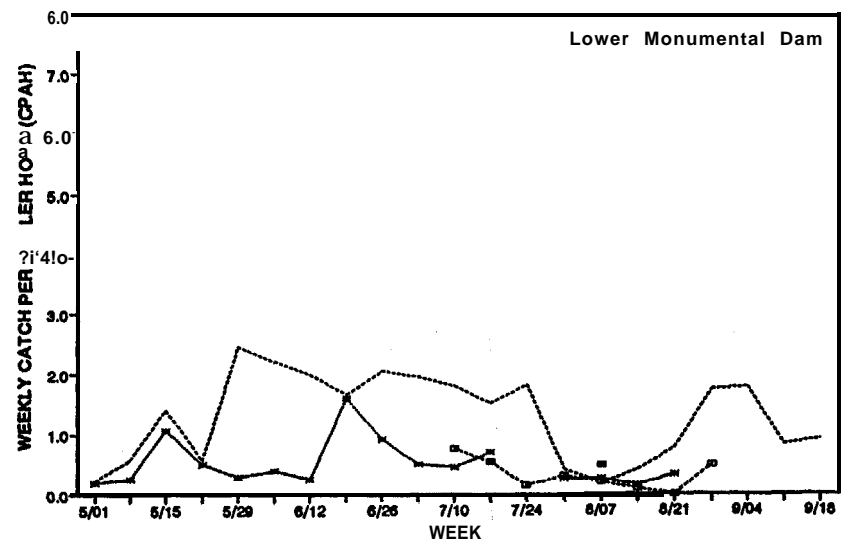
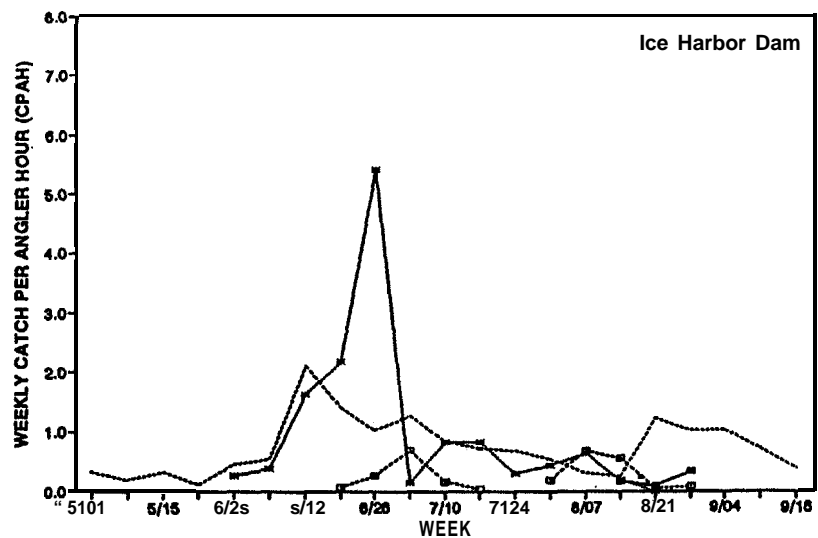


Figure 14. Weekly average catch per angler hour , (CPAH) at snake River dams. 1991 through 1994.

Table 4. Comparisons of catch and effort over four six-hour time periods for Columbia and Snake River dams, 1994.

| Time Period: | 0001-0600 | | | 0601-1200 | | | 1201-1800 | | | 1801-2400 | | |
|------------------------------|-----------|------------|------|-----------|------------|------|-----------|------------|------|-----------|------------|------|
| Dam | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH |
| <u>COLUMBIA RIVER</u> | | | | | | | | | | | | |
| Bonneville | 363 | 242.03 | 1.5 | 1,787 | 464.88 | 3.8 | 1253 | 737.32 | 1.7 | 1,835 | 787.32 | 2.3 |
| The Dalles | 709 | 398.32 | 1.8 | 410 | 249.38 | 1.6 | 1,271 | 552.43 | 2.3 | 2,003 | 863.80 | 2.3 |
| John Day | 2,143 | 845.05 | 2.5 | 234 | 247.30 | 1.0 | 44 | 102.12 | 0.4 | 662 | 454.48 | 1.5 |
| McNary | 734 | 1,026.62 | 0.7 | 910 | 1,020.70 | 0.9 | 317 | 411.73 | 0.8 | 595 | 506.97 | 1.2 |
| Season | 3,949 | 2,512.02 | 1.6 | 3,341 | 1,982.26 | 1.7 | 2,885 | 1,803.60 | 1.6 | 5,095 | 2,612.57 | 2.0 |
| <u>SNAKE RIVER</u> | | | | | | | | | | | | |
| Ice Harbor | | | | 21 | 97.57 | 0.2 | 2 | 43.28 | 0.1 | | | |
| Lower Monumental | | | | 22 | 41.37 | 0.5 | 5 | 14.08 | 0.4 | | | |
| Little Goose | 5 | 21.30 | 0.2 | 28 | 46.38 | 0.6 | 25 | 72.10 | 0.4 | 34 | 63.62 | 0.5 |
| Lower Granite | 155 | 171.50 | 0.9 | 214 | 267.48 | 0.8 | 187 | 151.08 | 1.2 | 129 | 101.92 | 1.3 |
| Season | 160 | 192.80 | 0.8 | 285 | 452.80 | 0.6 | 219 | 280.54 | 0.8 | 163 | 165.54 | 1.0 |
| TOTALS | 4,109 | 2,704.82 | 1.5 | 3,626 | 2,435.06 | 1.5 | 3,104 | 2,084.14 | 1.5 | 5,258 | 2,778.11 | 1.9 |

Angling Techniques

Volunteer **angling** supplemented resident-crew angling at Columbia River dams by contributing 3.2% (5 17) of the northern **squawfish** catch in 1994. **CPAHs** for volunteer **angling** crews were consistently lower than resident crews, except at McNary Dam (Table 5). Overall, **boat-angling** crews had a CPAH of 0.7; the resident-crew had a **CPAH** of 1.7. On the Columbia River, resident crews had the highest CPAH (1 .8), followed by volunteer **angling** (1 .5) and boat angling (0.8). At Snake River dams, where boat angling was the only supplemental technique used, the resident crew CPAH (0.8) was higher than that of boat angling (0.3).

Boat angling might have been more **effective** if used earlier in the season (May through early June), when discharge rates were high. **Boat-angling** efforts were often used late in the season when catch rates had declined. If boat angling were used as a primary **task**, as opposed to an alternative when dam angling is poor, we expect this method could be more effective.

Angler ability is an important factor **affecting** our overall success at dams. Differences between volunteer- and resident-angler success at some dams maybe explained by differences in angler ability. Furthermore, success varies greatly among resident anglers working the same dams and schedules (Figure 15).

Catch rates varied among different baits chosen by anglers (Table 6). At Columbia River dams, **soft** plastic bait (**SPO**) was used most often by anglers (84% of the total hours fished) and was relatively effective as measured by CPAH (Table 6). At Snake River dams, anglers preferred combination lures (CLO, used 70°A of the total hours fished), which also produced high catch rates (Table 6). The bait having the highest CPAH at a dam was not always the one most **often** used. This may be explained by limited availability or convenience of some baits, or insufficient transfer of catch **information** to anglers regarding the relative success of different baits.

Hydrological Effects

Changes in flow **affect** the distribution of northern **squawfish** near dams (Faler et al. 1988; R. Shively, NBS, unpublished data). Specifically, in the spring and early summer when discharge rates are **high**, northern squawfish are found in protected areas away from dams. When flows decrease, they move closer to dams, presumably to **feed** on **outmigrating** juvenile **salmonids**. Assuming dam **angling** catch rates are a measure of northern **squawfish** density near dams, our data seem to support this hypothesis. There appears to be an inverse relationship between outflow and CPAH in the short term at many **dams**; that is, peaks in CPAH **often** coincide with declines in discharge (Figures 16 and 17). This supports a management approach that uses boats in the boat restricted zones during periods of high flow to target concentrations of northern **squawfish** out of reach of dam-based anglers.

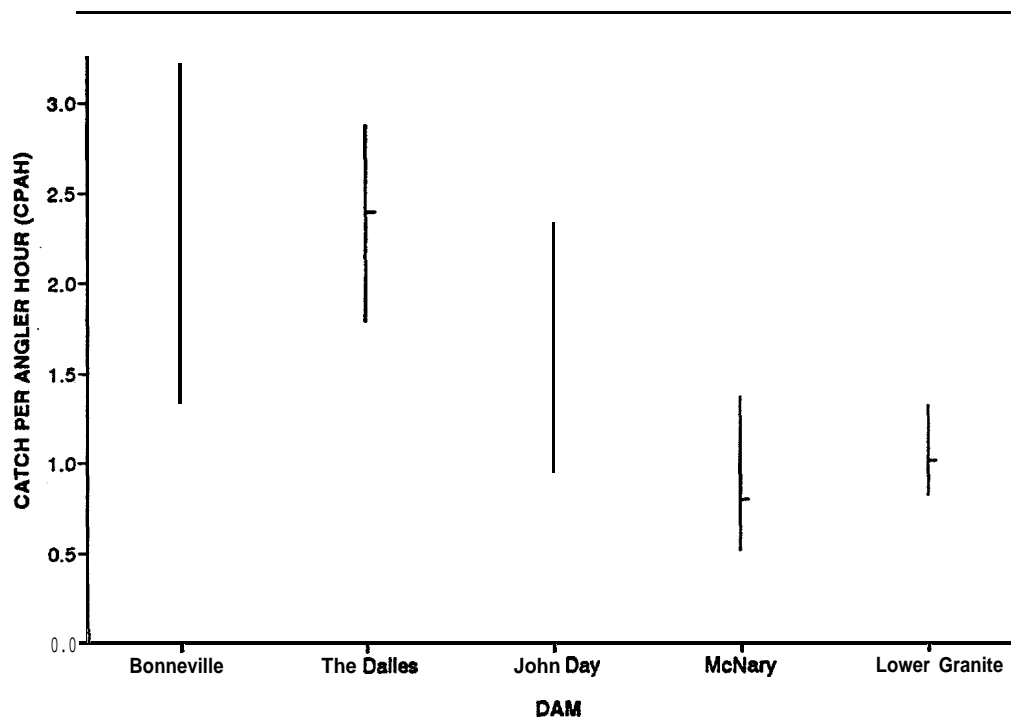


Figure 15. Range in angler effectiveness (CPAH) for each angling crew. Mobile crew, volunteer angling crews, and anglers who worked fewer than 100 hours are not included. Average CPAH for each crew is indicated by a horizontal mark.

Table 6. Comparisons of the effectiveness of baits used throughout the 1994 season at each dam. Baits are listed from highest to lowest CPAH.

| Season totals by dam | | | | | Season totals by river system | | | |
|-----------------------|-------|-------|------------|------|---|--------|------------|------|
| Dam | Bait* | NSF | Effort (h) | CPAH | Bait* | NSF | Effort (h) | CPAH |
| COLUMBIA RIVER | | | | | COLUMBIA RIVER | | | |
| Bonneville | HML | 93 | 21.82 | 4.3 | HML | 102 | 38.54 | 2.7 |
| | SPO | 4,788 | 1,809.57 | 2.7 | SPO | 13,514 | 7,492.12 | 1.8 |
| | HPO | 300 | 217.27 | 1.4 | HPO | 784 | 443.48 | 1.8 |
| | NBo | 57 | 182.08 | 0.3 | NBo | 836 | 892.80 | 0.9 |
| | CLO | 0 | 0.82 | 0.0 | CLO | 34 | 43.52 | 0.8 |
| The Dalles | HPO | 398 | 148.95 | 2.7 | SNAKE RIVER | | | |
| | SPO | 3,909 | 1,854.82 | 2.1 | NBo | 160 | 166.62 | 1.0 |
| | NBo | 85 | 56.52 | 1.5 | CLO | 590 | 767.55 | 0.8 |
| | HML | 1 | 3.65 | 0.3 | SPO | 47 | 71.95 | 0.7 |
| John Day | s Po | 2,998 | 1,572.50 | 1.9 | HPO | 30 | 85.23 | 0.4 |
| | HPO | 69 | 52.05 | 1.3 | HML | 0 | 0.33 | 0.0 |
| | HML | 7 | 9.22 | 0.8 | TOTALS | | | |
| | CLO | 8 | 10.50 | 0.8 | HML | 102 | 38.87 | 2.6 |
| | NBo | 1 | 4.68 | 0.2 | SPO | 13,561 | 7,564.07 | 1.8 |
| McNary | NBo | 693 | 649.52 | 1.1 | HPO | 814 | 528.72 | 1.5 |
| | SPO | 1,819 | 2,255.23 | 0.8 | NBo | 996 | 1,059.42 | 0.9 |
| | CLO | 26 | 32.20 | 0.8 | CLO | 624 | 811.07 | 0.8 |
| | HPO | 17 | 25.22 | 0.7 | | | | |
| | HML | 1 | 3.85 | 0.3 | | | | |
| SNAKE RIVER | | | | | | | | |
| Ice Harbor | NBo | 1 | 2.05 | 0.5 | .Bait descriptions | | | |
| | SPO | 6 | 26.13 | 0.2 | HML = Hard Metal Lures (such as spoons, spinners, Zonars) | | | |
| | CLO | 16 | 103.40 | 0.2 | SPO = Soft Plastic (such as grubs, tubes, fish-like grubs) | | | |
| | HPO | 0 | 9.27 | 0.0 | HPO = Hard Plastic (such as plugs, Rat-L-Traps, and Rapalas) | | | |
| Lower | CLO | 27 | 43.50 | 0.6 | NBO = Natural Bait (such as worms, lamprey, and smelts) | | | |
| Monumental | NBo | 0 | 1.57 | 0.0 | CLO = Combination Lures (any combination of the classes listed above) | | | |
| | SPO | 0 | 3.57 | 0.0 | | | | |
| | HPO | 0 | 6.82 | 0.0 | | | | |
| Little Goose | SPO | 5 | 9.00 | 0.6 | | | | |
| | NBo | 15 | 31.03 | 0.5 | | | | |
| | CLO | 66 | 138.28 | 0.5 | | | | |
| | HPO | 6 | 25.08 | 0.2 | | | | |
| Lower Granite | NBo | 144 | 131.97 | 1.1 | | | | |
| | SPO | 36 | 33.25 | 1.1 | | | | |
| | CLO | 481 | 482.37 | 1.0 | | | | |
| | HPO | 24 | 44.07 | 0.5 | | | | |
| | HML | 0 | 0.33 | 0.0 | | | | |

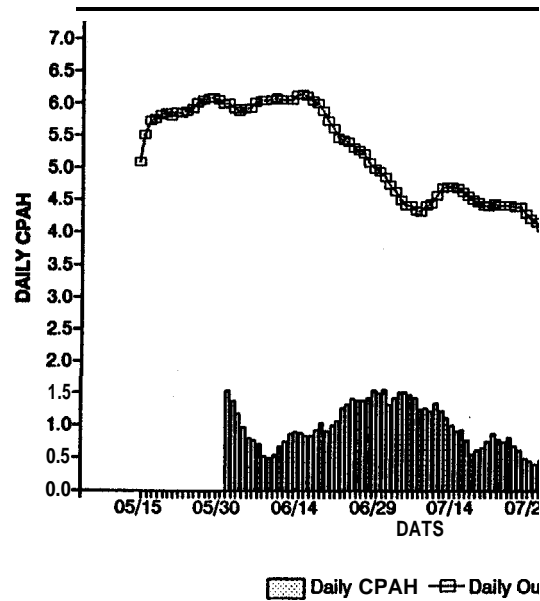
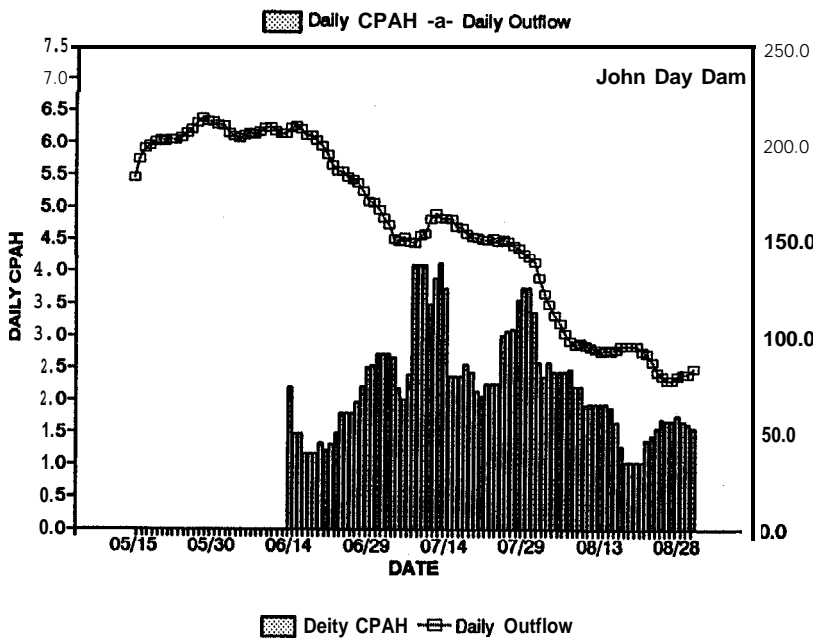
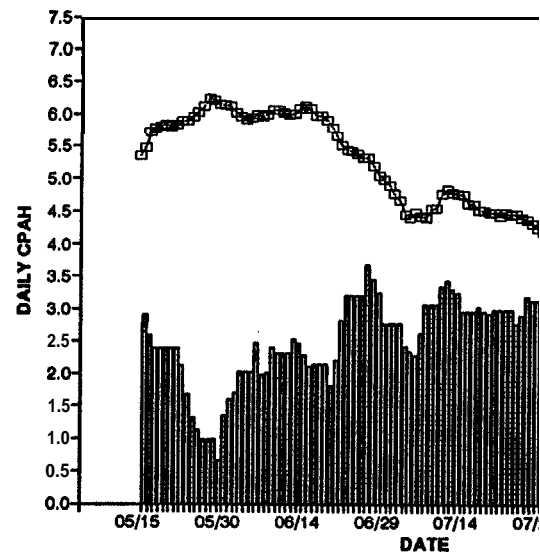
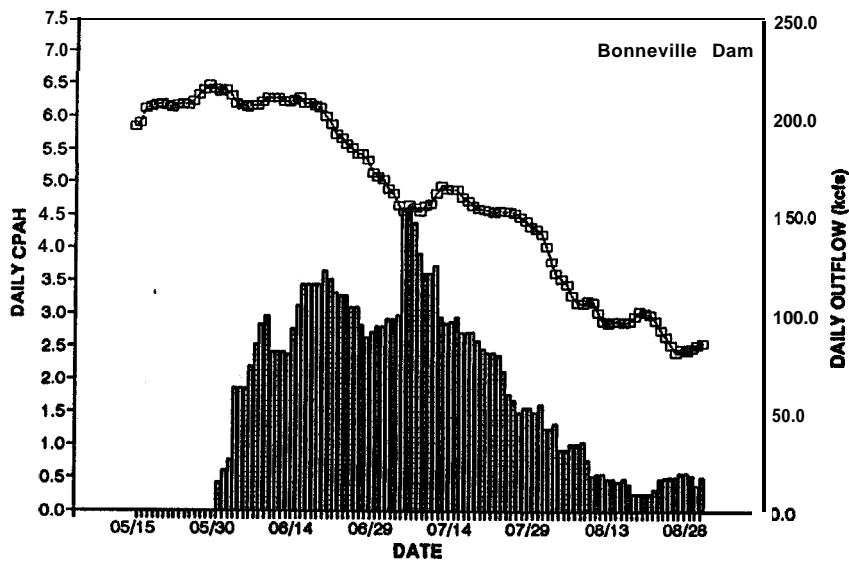


Figure 16. Northern squawfish catch per angler hour (CPAH) and dam outflow at Columbia River

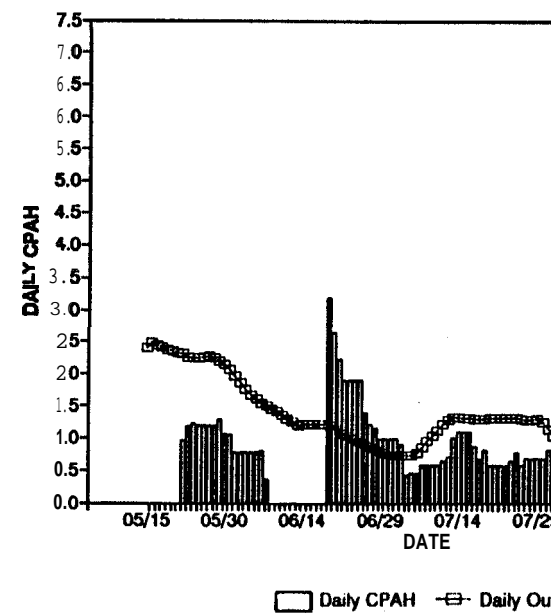
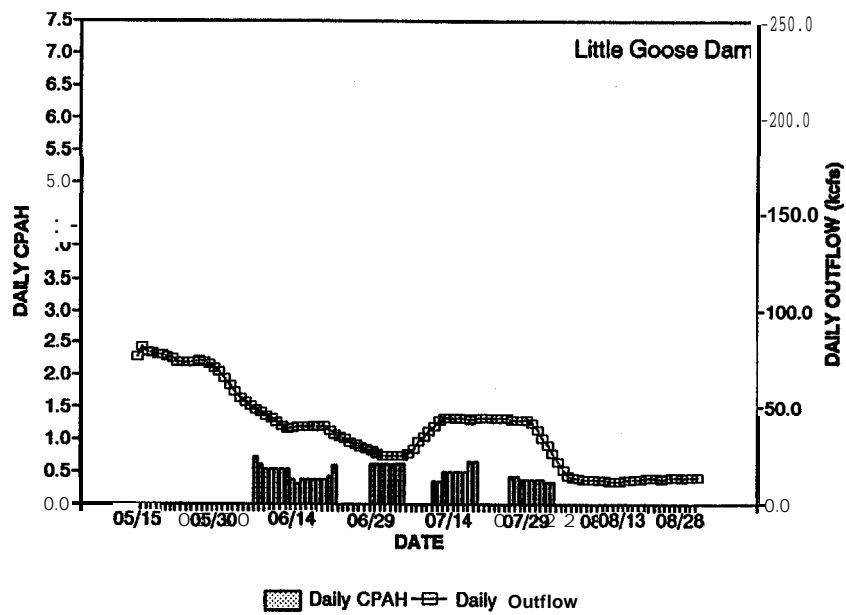
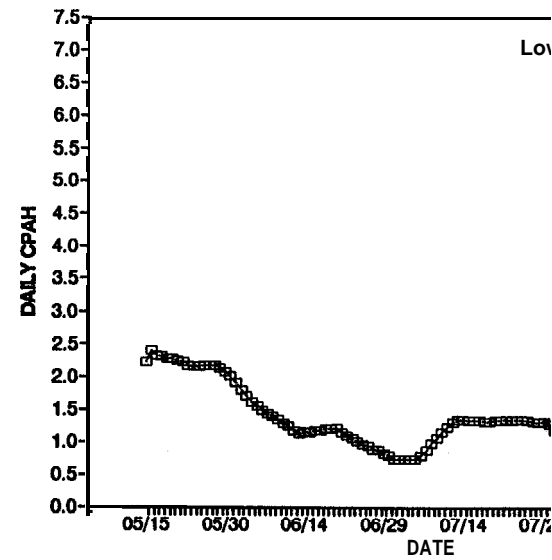
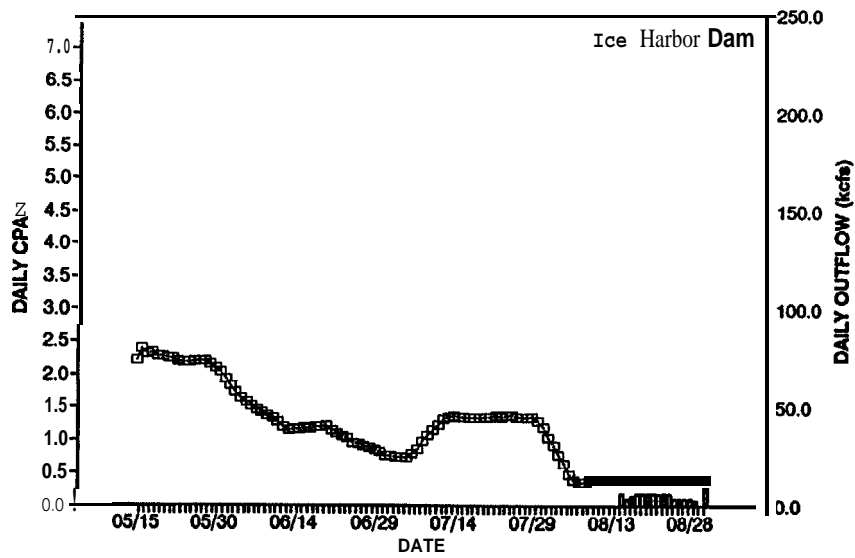


Figure 17. Northern squawfish catch per angler hour (CPAH) and dam outflow at snake River

Smelt Passage

Northern **squawfish** concentrate below Columbia River and Snake River dams to feed on juvenile **salmonids** that are injured or disoriented **after** passing the dam (**Beamesderfer** and **Rieman** 1991). A **prediction** of this hypothesis is that northern **squawfish** density near dams would be greatest during peak passage periods **of juvenile** salmonids. Our data seem to support this prediction. There appears to be a direct relationship between an index of juvenile **salmonid** passage and **CPAH** at dams in the short term (**Figures** 18 and 19). Furthermore, these data indicate **angling** at many dams started **after** the peak passage period for juvenile **salmonids** (**Figures** 18 and 19), suggesting that an earlier start of dam angling activities might have been more productive.

Incidental Catch

In 1994, 2.3% of the total catch was composed of incidental species (Figure 20; Appendix Tables A-3 through A-8), which was less than half of that in 1993 (5.5%). Of the 374 incidentally caught **fish**, there were 46% bass, 20% **sturgeon**, 11% **catfish**, 11% walleye, 6% other (e.g., sucker, **peamouth**), 3% shad, and 3% **salmonids**. Of the 12 incidentally caught **salmonids** (six unidentified and six steelhead; 0.07% of **all** fish caught), **all** were **juveniles**; nine were released in good condition, two in poor **condition**, and one died. **All** incidentally caught **salmonids** were caught at Columbia River dams.

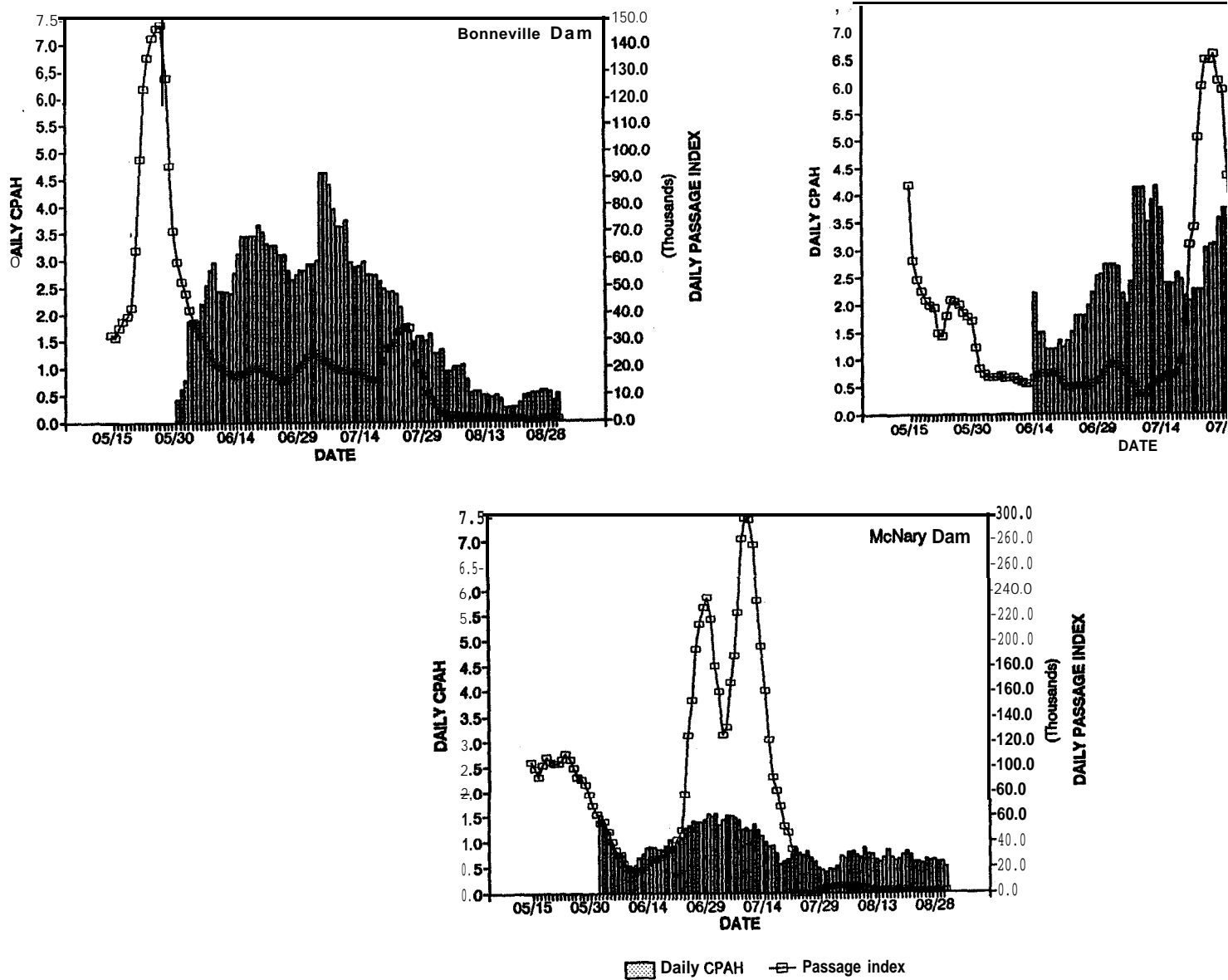


Figure 18. Northern squawfish catch per angler hour (CPAH) and smelt passage indices at Colu. Passage information not available for The Dalles Dam. Note different scales for passage index.

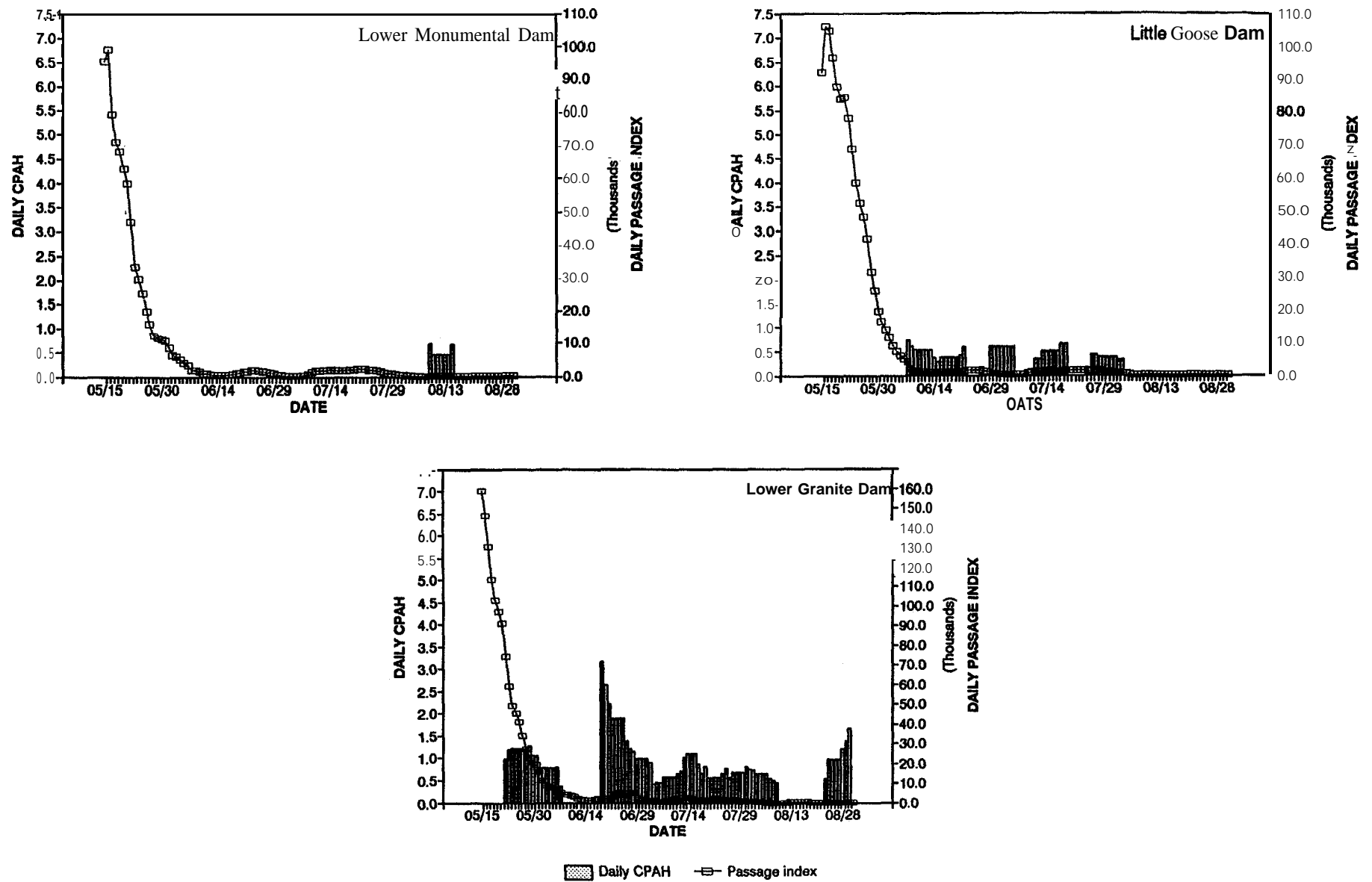


Figure 19. Northern squawfish catch per angler hour (CPAH) and smelt passage indices at Snake River dams , 1994. Passage information not available for Ice Harbor Dam. Note different scales for passage index.

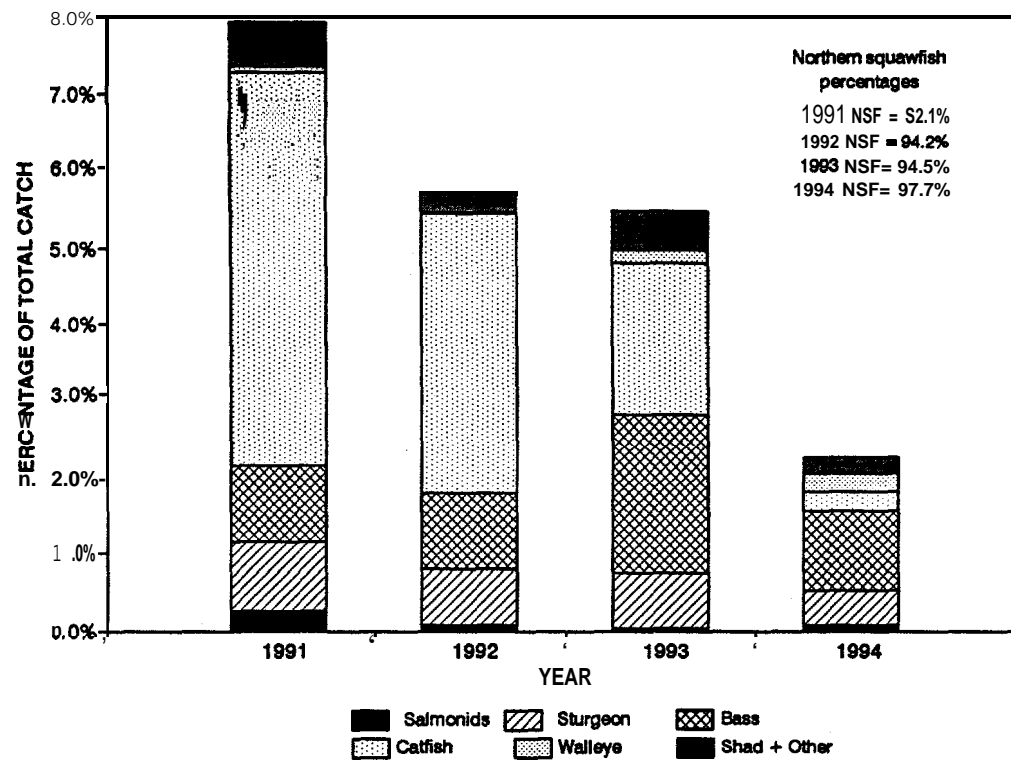


Figure 20. Percentage of total catch of all incidentally caught fish and northern squawfish at Columbia and Snake River dams during 1991, 1992, 1993, and 1994.

CONCLUSIONS AND RECOMMENDATIONS

- L Conclusion** - Hook-and-line angling at lower Columbia River and Snake River dams continues to be effective **in** removing predator-sized northern **squawfish** from areas where predation rates are high. Catch rates at **Columbia** River dams continue to be high at the lower-most dams (Bonneville and The **Dalles**), whereas McNary Dam was less productive. At Snake River dams, Lower Granite Dam continues to be the most productive.

Recommendation - Continue controlled angling at all eight dams, concentrating most of the angling effort on the Columbia River. Specifically, increase effort (based on weekly catch rates) at Bonneville and The **Dalles** dams using one large crew whose effort is distributed between the two dams. Also, reduce effort at McNary Dam and maintain a level of effort at John Day Dam similar to that in 1994. Finally, continue to use one mobile crew at **all** Snake River dams with most of its effort directed at Lower Granite Dam.

2. **Conclusion** - In 1994, the most productive months at Columbia River and Snake River dams were July and May, respectively, which was consistent with results from previous years. Dawn and dusk continue to be the most productive time periods at most dams.

Recommendation - Distribute **angling** effort at each dam to improve efficiency. Daily effort should be distributed based on inseason monitoring of catch data and should encompass the most productive dams and time periods. Schedules and **staffing** levels should be:

| Dam | Anglers | Season & effort pattn |
|-------------------|----------------|---|
| Bonneville | 6 | May through August |
| The Dalles | 6 | May through August |
| John Day | 4 | Mid-June through early Sept. |
| McNary | 5 | June through August |
| Snake River dams | 4 | May through July; all dams staffed by a single crew |

3. **Conclusion** - Results presented here suggest that dam outflow and catch rate of northern **squawfish** maybe inversely related. These results are consistent with radio-tagging data (**R. Snively**, NBS, personal communication) that show when discharge rates are high northern **squawfish** are mostly found in protected areas away from the dam.

Recommendation - Continue to use boats in the boat restricted zones near dams to target concentrations of northern **squawfish** beyond the reach of dam-based anglers, particularly during periods of high dam outflow. Expand these **efforts** below Columbia River dams to include a mobile crew whose **primary** responsibility will be to conduct **boat-based angling**, lure trolling, and **longlining** techniques. We include **longlining** on an experimental basis because its use may be effective when limited to boat restricted zones.

4. Conclusion - Volunteer **angling** efforts continue to be productive in catching northern **squawfish** at a low cost. Furthermore, the volunteer program provides participants with an opportunity to learn about the Northern Squawfish Management Program and to work cooperatively with other cultural groups.

Recommendation - Expand the volunteer **angling** effort at Columbia River dams (e.g., 8-10 volunteer groups). Two technicians will be **dedicated** to coordinating and overseeing these operations.

5. Conclusion - Angler expertise is a significant factor affecting catch rates of northern squaw-fish at dams.

Recommendation - When making hiring decisions for dam-angling positions, continue to consider past performance (i.e., angler catch and effort) for applicants previously employed on dam angling crews, and consider other hook-and-line angling experience for those not previously involved with the program.

6. Conclusion - Within-season evaluation of **angling** techniques and schedules is effective in maximizing catch rates of northern **squawfish** and **minimizing** the incidental catch of **salmonids** and sturgeon.

Recommendation - Continue analyzing data to better understand the factors **affecting** catch rates, and facilitate the timely transfer of that **information** to angling crews.

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Vigg, S., C. C. Burley, D. L. Ward, C. Mallette, S. Smith, and M. Zimmerman. 1990. Development of a system-wide predator control program: stepwise implementation of a predator **index**, predator control fisheries, and evaluation plan in the **Columbia** River Basin. Pages 7-111 *in* **A. A. Nigro, editor.** Development of a system-wide predator control program Stepwise implementation of a predation **index**, predator control fisheries, and evaluation plan in the Columbia River Basin. Annual Report (Contract **DE-BI79-90BP07084**) to Bonneville Power Administration Portland, Oregon.

APPENDIX A

1994 Tabular Data

Appendix Table A-1. **Northern squawfish** catch, effort, and catch per angler hour(CPAH), by statistical week, at Columbia River dams, 1994.

| Statistical week # | Bonneville | | | The Dalles | | | John Day | | | McNary | | |
|-----------------------|--------------|-----------------|------------|-------------|-----------------|------------|--------------|-----------------|------------|--------------|-----------------|------------|
| | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH |
| 20: 5108-5/14 | | | | 77 | 22.73 | 3.4 | | | | | | |
| 21: 5/15-5/21 | | | | 105 | 46.47 | 2.3 | | | | | | |
| 22: 5122-5/28 | | | | 188 | 223.07 | 0.8 | | | | | | |
| 23:5129-6104 | 138 | 108.25 | 1.3 | 140 | 110.37 | 1.3 | | | | 92 | 76.57 | 1.2 |
| 24: 6/05-6/11 | 456 | 186.25 | 2.4 | 343 | 146.15 | 2.3 | | | | 106 | 193.62 | 0.5 |
| 25:6112-6118 | 407 | 119.15 | 3.4 | 275 | 137.78 | 2.0 | 114 | 99.28 | 1.1 | 191 | 226.78 | 0.8 |
| 26:6119-6125 | 715 | 227.48 | 3.1 | 423 | 128.48 | 3.3 | 204 | 111.05 | 1.8 | 375 | 276.03 | 1.4 |
| 27: 6/26-7/02 | 530 | 178.73 | 3.0 | 639 | 247.33 | 2.6 | 274 | 101.57 | 2.7 | 346 | 222.57 | 1.6 |
| 28: 7/03-7109 | 979 | 246.48 | 4.0 | 455 | 157.65 | 2.9 | 214 | 67.97 | 3.1 | 313 | 259.88 | 1.2 |
| 29: 7/10-7116 | 688 | 219.15 | 3.1 | 383 | 140.82 | 2.7 | 276 | 104.87 | 2.6 | 213 | 244.43 | 0.9 |
| 30: 7/17-7/23 | 623 | 221.80 | 2.8 | 374 | 130.43 | 2.9 | 344 | 159.87 | 2.2 | 188 | 215.62 | 0.9 |
| 31:7124-7130 | 365 | 196.53 | 1.9 | 441 | 148.07 | 3.0 | 195 | 62.33 | 3.1 | 118 | 273.20 | 0.4 |
| 32: 7/31-8106 | 164 | 151.98 | 1.1 | 167 | 99.78 | 1.7 | 253 | 100.25 | 2.5 | 123 | 174.82 | 0.7 |
| 33:8107-8113 | 76 | 159.87 | 0.5 | 138 | 97.72 | 1.4 | 184 | 94.05 | 2.0 | 119 | 227.05 | 0.5 |
| 34: 8114-8/20 | 29 | 108.10 | 0.3 | 92 | 86.83 | 1.1 | 224 | 222.62 | 1.0 | 197 | 253.83 | 0.8 |
| 35:8121-8127 | 56 | 100.60 | 0.6 | 136 | 86.97 | 1.6 | 369 | 237.82 | 1.6 | 129 | 212.82 | 0.6 |
| 36: 8/28-9103 | 12 | 7.17 | 1.7 | 17 | 53.28 | 0.3 | 235 | 192.10 | 1.2 | 46 | 108.80 | 0.4 |
| 37:9104-9110 | | | | | | | 197 | 95.18 | 2.1 | | | |
| Season | 5,238 | 2,231.55 | 2.4 | 4493 | 2,063.93 | 2.1 | 3,083 | 1,648.95 | 1.9 | 2,556 | 2,966.02 | 0.9 |

Appendix Table A-2. **Northern squawfish** catch, effort, and catch per angler hour (**CPAH**), by statistical week, at Snake River dams, 1994.

| Statistical week # | Ice Harbor | | | Lower Monumental | | | Little Goose | | | Lower Granite | | |
|-----------------------|------------|---------------|------|------------------|---------------|------|--------------|---------------|------------|---------------|---------------|------------|
| | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH | NSF | Effort (h) | CPAH |
| 22: 5/22-5/28 | | | | | | | | | | 93 | 76.65 | 1.2 |
| 23: 5/29-6/04 | | | | | | | | | | 35 | 48.25 | 0.7 |
| 24: 6/05-6/11 | | | | | | | 29 | 56.02 | 0.5 | | | |
| 25: 6/12-6/18 | | | | | | | 21 | 56.30 | 0.4 | | | |
| 26: 6/19-6/25 | | | | | | | | | | 160 | 90.33 | 1.8 |
| 27: 6/26-7/02 | | | | | | | 12 | 19.80 | 0.6 | 62 | 64.85 | 1.0 |
| 28: 7/03-7/09 | | | | | | | | | | 36 | 64.12 | 0.6 |
| 29: 7/10-7/16 | | | | | | | 17 | 35.82 | 0.5 | 52 | 47.17 | 1.1 |
| 30: 7/17-7/23 | | | | | | | | | | 38 | 66.42 | 0.6 |
| 31: 7/24-7/30 | | | | | | | 13 | 35.47 | 0.4 | 32 | 46.57 | 0.7 |
| 32: 7/31-8/06 | | | | | | | | | | 69 | 105.07 | 0.7 |
| 33: 8/07-8/13 | | | | 27 | 55.45 | 0.5 | | | | | | |
| 34: 8/14-8/20 | 14 | 84.37 | 0.2 | | | | | | | | | |
| 35: 8/21-8/27 | 4 | 41.57 | 0.1 | | | | | | | 46 | 47.72 | 1.0 |
| 36: 8/28-9/03 | 5 | 14.92 | 0.3 | | | | | | | 62 | 34.85 | 1.8 |
| Season | 23 | 140.85 | 0.2 | 27 | 55.45 | 0.5 | 92 | 203.4 | 0.5 | 68s | 691.98 | Lo |

Appendix Table A-3. Monthly species composition of dam angling catch for Columbia and Snake River dams, 1994.

| Month | Percent northern squawfish in total catch | Percent incidental species in total catch | Percent of total catch by species | | | | | | |
|------------------------------|---|---|-----------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| | | | Salmonids | Sturgeon | Bsas | Catfish | Walleye | shad | Other |
| <u>COLUMBIA RIVER</u> | | | | | | | | | |
| May | 95.82% | 4.18% | 0.00% | 0.00% | 3.08% | 0.00% | 0.22% | 0.00% | 0.88% |
| June | 98.28% | 1.72% | 0.07% | 0.28% | 0.91% | 0.09% | 0.07% | 0.14% | 0.16% |
| July | 98.70% | 1.30% | 0.05% | 0.19% | 0.74% | 0.19% | 0.08% | 0.05% | 0.02% |
| August | 95.24% | 4.76% | 0.18% | 1.38% | 1.85% | 0.07% | 1.03% | 0.00% | 0.25% |
| September | 99.26% | 0.74% | 0.00% | 0.00% | 0.37% | 0.00% | 0.37% | 0.00% | 0.00% |
| Season | 97.85% | 2.15% | 0.08% | 0.43% | 1.06% | 0.12% | 0.26% | 0.07% | 0.13% |
| <u>SNAKE RIVER</u> | | | | | | | | | |
| May | 98.15% | 1.85% | 0.00% | 0.00% | 0.00% | 1.85% | 0.00% | 0.00% | 0.00% |
| June | 98.39% | 1.61% | 0.00% | 0.32% | 0.00% | 0.96% | 0.00% | 0.00% | 0.32% |
| July | 94.00% | 6.00% | 0.00% | 1.00% | 1.50% | 3.50% | 0.00% | 0.00% | 0.00% |
| August | 92.28% | 7.72% | 0.00% | 1.63% | 0.41% | 4.88% | 0.00% | 0.00% | 0.81% |
| Season | 95.61% | 4.39% | 0.00% | 0.81% | 0.46% | 2.77% | 0.00% | 0.00% | 0.35% |
| <u>GRAND TOTALS</u> | | | | | | | | | |
| May | 96.27% | 3.73% | 0.00% | 0.00% | 2.49% | 0.36% | 0.18% | 0.00% | 0.71% |
| June | 98.29% | 1.71% | 0.07% | 0.28% | 0.87% | 0.13% | 0.07% | 0.13% | 0.17% |
| July | 98.55% | 1.45% | 0.05% | 0.21% | 0.76% | 0.29% | 0.08% | 0.05% | 0.02% |
| August | 95.00% | 5.00% | 0.16% | 1.40% | 1.73% | 0.46% | 0.95% | 0.00% | 0.29% |
| September | 99.26% | 0.74% | 0.00% | 0.00% | 0.37% | 0.00% | 0.37% | 0.00% | 0.00% |
| Season | | | | | | | | | |

Appendix Table A-4. Monthly catch of incidental species by condition at release for Columbia and Snake river dams, 1994. Condition codes: 1) minimal injury, certain to survive, 2) moderate injury, may or may not survive, 3) dead, nearly dead, or certain to die, L) line cut or broken, fish not removed from the water.

| Moderate injury, may or may not survive, S/ dead, nearly dead, or certain to die, L/ line cut or broken, fish not removed from the water. | | | | | | | | | | | | | | | | | | | | | |
|---|---------------------------|------------------------|-----------|---|---|---|----------|---|---|----|------|---|---|---------|---|---|---------|---|---|------|-------|
| Month | Total catch (all species) | Total incidental catch | Salmonids | | | | Sturgeon | | | | Bass | | | Cattish | | | Walleye | | | Shad | Other |
| | | | 1 | 2 | 3 | L | 1 | 2 | 3 | L | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | | |
| <u>COLUMBIA RIVER</u> | | | | | | | | | | | | | | | | | | | | | |
| May | 455 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| June | 5,698 | 98 | 4 | 0 | 0 | 0 | 7 | 0 | 0 | 9 | 52 | 0 | 0 | 5 | 0 | 0 | 4 | 0 | 0 | 8 | 9 |
| July | 6,367 | 83 | 2 | 1 | 0 | 0 | 9 | 0 | 0 | 3 | 45 | 2 | 0 | 12 | 0 | 0 | 4 | 1 | 0 | 3 | 1 |
| August | 2,817 | 134 | 3 | 1 | 1 | 0 | 9 | 1 | 0 | 29 | 50 | 1 | 1 | 2 | 0 | 0 | 28 | 1 | 0 | 0 | 7 |
| September | 269 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Season | 18,606 | 336 | 9 | 2 | 1 | 0 | 25 | 1 | 0 | 41 | 162 | 3 | 1 | 19 | 0 | 0 | 38 | 2 | 0 | 11 | 21 |
| <u>SNAKE RIVER</u> | | | | | | | | | | | | | | | | | | | | | |
| May | 108 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| June | 311 | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| July | 200 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| August | 246 | 19 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Season | 865 | 38 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 6 | 4 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| <u>GRAND TOTALS</u> | | | | | | | | | | | | | | | | | | | | | |
| May | 563 | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| June | 6,009 | 103 | 4 | 0 | 0 | 0 | 8 | 0 | 0 | 9 | 52 | 0 | 0 | 8 | 0 | 0 | 4 | 0 | 0 | 8 | 10 |
| July | 6,567 | 95 | 2 | 1 | 0 | 0 | 9 | 0 | 0 | 5 | 48 | 2 | 0 | 19 | 0 | 0 | 4 | 1 | 0 | 3 | 1 |
| August | 3,063 | 153 | 3 | 1 | 1 | 0 | 9 | 1 | 0 | 33 | 51 | 1 | 1 | 14 | 0 | 0 | 28 | 1 | 0 | 0 | 9 |
| September | 269 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Season | 16,471 | 374 | 9 | 2 | 1 | 0 | 26 | 1 | 0 | 47 | 166 | 3 | 1 | 43 | 0 | 0 | 38 | 2 | 0 | 11 | 24 |

Appendix Table A-5. Monthly species composition of dam angling catch for Columbia River dams, 1994.

| | Percent northern squawfish in total catch | Percent incidental species in total catch | Percent of total catch by species | | | | | | |
|--------------------------|---|---|-----------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Month | | | Salmonids | Sturgeon | Bass | Catfish | Walleye | Shad | Other |
| <u>BONNEVILLE</u> | | | | | | | | | |
| May | 94.12% | 5.88% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 5.88% |
| June | 99.29% | 0.71% | 0.13% | 0.18% | 0.00% | 0.00% | 0.00% | 0.27% | 0.13% |
| July | 99.77% | 0.23% | 0.04% | 0.03% | 0.08% | 0.00% | 0.00% | 0.04% | 0.00% |
| August | 88.80% | 11.20% | 1.09% | 8.74% | 0.27% | 0.00% | 0.55% | 0.00% | 0.55% |
| be | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Season | 98.79% | 1.21% | 0.15% | 0.72% | 0.06% | 0.00% | 0.04% | 0.13% | 0.11% |
| <u>THE DALLES</u> | | | | | | | | | |
| May | 95.89% | 4.11% | 0.00% | 0.00% | 3.20% | 0.00% | 0.23% | 0.00% | 0.68% |
| June | 96.99% | 3.01% | 0.00% | 0.16% | 2.52% | 0.00% | 0.22% | 0.00% | 0.11% |
| July | 97.41% | 2.59% | 0.06% | 0.06% | 2.24% | 0.00% | 0.24% | 0.00% | 0.00% |
| August | 89.72% | 10.28% | 0.00% | 0.82% | 7.50% | 0.00% | 1.79% | 0.00% | 0.16% |
| season | 96.06% | 3.94% | 0.02% | 0.20% | 3.15% | 0.00% | 0.44% | 0.00% | 0.13% |
| <u>JOHN DAY</u> | | | | | | | | | |
| June | 99.00% | 1.00% | 0.17% | 0.17% | 0.00% | 0.00% | 0.00% | 0.33% | 0.33% |
| July | 98.47% | 1.53% | 0.10% | 0.38% | 0.67% | 0.10% | 0.10% | 0.19% | 0.00% |
| August | 98.29% | 1.71% | 0.08% | 0.08% | 0.24% | 0.00% | 1.31% | 0.00% | 0.00% |
| September | 99.22% | 0.78% | 0.00% | 0.00% | 0.39% | 0.00% | 0.39% | 0.00% | 0.00% |
| Season | 98.56% | 1.44% | 0.10% | 0.19% | 0.35% | 0.03% | 0.58% | 0.13% | 0.06% |
| <u>McNARY</u> | | | | | | | | | |
| June | 97.96% | 2.04% | 0.00% | 0.78% | 0.58% | 0.49% | 0.00% | 0.00% | 0.19% |
| July | 98.23% | 1.77% | 0.00% | 0.52% | 0.00% | 1.14% | 0.00% | 0.00% | 0.10% |
| August | 98.53% | 1.47% | 0.00% | 0.16% | 0.33% | 0.33% | 0.00% | 0.00% | 0.65% |
| | | | | | 0.31% | 0.69% | 0.00% | 0.00% | 0.27% |

Appendix Table A-6. Monthly catch of incidental species by condition at release for Columbia River dams, 1994. Condition **codes:** 1) minimal injury, certain to **survive**; 2) moderate injury, may or may not **survive**; 3) dead, nearly dead, or certain to die, L) line cut or broken, fish not removed from the water.

| Month | Total catch (all species) | Total incidental catch | Salmonids | | | | Sturgeon | | | | Bass | | | Cattish | | | Walleye | | | Shad | Other |
|--------------------------|---------------------------|------------------------|-----------|---|---|---|----------|---|---|----|------|---|---|---------|---|---|---------|---|---|------|-------|
| | | | 1 | 2 | 3 | L | 1 | 2 | 3 | L | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | | |
| <u>BONNEVILLE</u> | | | | | | | | | | | | | | | | | | | | | |
| May | 17 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| June | 2,246 | 16 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 3 |
| July | 2,661 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| August | 366 | 41 | 3 | 0 | 1 | 0 | 5 | 0 | 0 | 27 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| September | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Season | 5,302 | 64 | 6 | 1 | 1 | 0 | 6 | 0 | 0 | 32 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 7 | 6 |
| <u>THE DALLES</u> | | | | | | | | | | | | | | | | | | | | | |
| May | 438 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 |
| June | 1,825 | 55 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | 46 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 2 |
| July | 1,697 | 44 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 37 | 1 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 |
| August | 613 | 63 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 44 | 1 | 1 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 1 |
| Season | 4,573 | 180 | 1 | 0 | 0 | 0 | 5 | 0 | 0 | 4 | 141 | 2 | 1 | 0 | 0 | 0 | 19 | 1 | 0 | 0 | 6 |
| <u>JOHN DAY</u> | | | | | | | | | | | | | | | | | | | | | |
| June | 598 | 6 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| July | 1,047 | 16 | 1 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 6 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 |
| August | 1,226 | 21 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 16 | 0 | 0 | 0 | 0 |
| September | 257 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| Season | 3,128 | 45 | 2 | 1 | 0 | 0 | 5 | 1 | 0 | 0 | 10 | 1 | 0 | 1 | 0 | 0 | 18 | 0 | 0 | 4 | 2 |
| <u>McNARY</u> | | | | | | | | | | | | | | | | | | | | | |
| June | 1,029 | 21 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 4 | 6 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| July | 962 | 17 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| August | 612 | 9 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| Season | 2,603 | 47 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 5 | 8 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 7 |

Appendix Table A-7. Monthly species composition of dam angling catch for Snake River dams, 1994.

| Month | Percent northern squawfish in total catch | Percent incidental species in total catch | Percent of total catch by species | | | | | | |
|-------------------------|---|---|-----------------------------------|----------|-------|---------|---------|-------|-------|
| | | | Salmonids | Sturgeon | Bass | Catfish | Walleye | Shad | Other |
| <u>ICE HARBOR</u> | | | | | | | | | |
| August | 65.71 % | 34.29% | 0.00% | 8.57% | 2.86% | 17.14% | 0.00% | 0.00% | 5.71% |
| Season | 65.71 % | 34.29% | 0.00% | 8.57% | 2.86% | 17.14% | 0.00% | 0.00% | 5.71% |
| <u>LOWER MONUMENTAL</u> | | | | | | | | | |
| August | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| Season | 100.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| <u>LITTLE GOOSE</u> | | | | | | | | | |
| June | 96.88% | 3.13% | 0.00% | 0.00% | 0.00% | 3.13% | 0.00% | 0.00% | 0.00% |
| July | 85.71% | 14.29% | 0.00% | 0.00% | 8.57% | 5.71% | 0.00% | 0.00% | 0.00% |
| Season | 92.93% | 7.07% | 0.00% | 0.00% | 3.03% | 4.04% | 0.00% | 0.00% | 0.00% |
| <u>LOWER GRANITE</u> | | | | | | | | | |
| May | 98.15% | 1.85% | 0.00% | 0.00% | 0.00% | 1.85% | 0.00% | 0.00% | 0.00% |
| June | 98.79% | 1.21% | 0.00% | 0.40% | 0.00% | 0.40% | 0.00% | 0.00% | 0.40% |
| July | 95.76% | 4.24% | 0.00% | 1.21% | 0.00% | 3.03% | 0.00% | 0.00% | 0.00% |
| August | 96.20% | 3.80% | 0.00% | 0.54% | 0.00% | 3.26% | 0.00% | 0.00% | 0.00% |
| Season | 97.30% | 2.70% | 0.00% | 0.57% | 0.00% | 1.99% | 0.00% | 0.00% | 0.14% |

Appendix Table A-8. Monthly catch of incidental species by condition at release for Snake River dam, 1994. Condition codes: 1) minimal injury, certain to survive; 2) moderate injury, mayor may not survive, 3) dead, nearly dead, or certain to die, L) line cut or broken, fish not removed from the water.

| Month | Total catch (all species) | Total incidental catch | Salmonids | | | | Sturgeon | | | Bass | | | Catfish | | | Walleye | | | Shad | Other |
|-------------------------|---------------------------|------------------------|-----------|---|---|---|----------|---|----|------|---|---|---------|----|---|---------|---|---|------|-------|
| | | | 1 | 2 | 3 | L | 1 | 2 | 3L | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | | |
| | | | | | | | | | | | | | | | | | | | | |
| <u>ICE HARBOR</u> | | | | | | | | | | | | | | | | | | | | |
| August | 35 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 2 |
| Season | 35 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 2 |
| <u>LOWER MONUMENTAL</u> | | | | | | | | | | | | | | | | | | | | |
| August | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Season | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| <u>LITTLE GOOSE</u> | | | | | | | | | | | | | | | | | | | | |
| June | 64 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| July | 35 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Season | 99 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| <u>LOWER GRANITE</u> | | | | | | | | | | | | | | | | | | | | |
| May | 108 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| June | 247 | 3 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| July | 165 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| August | 184 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Season | 704 | 19 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 3 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 1 |

APPENDIX B

Crew Questionnaire

In 1994, a questionnaire was given to resident-crew members to gain **useful** information about the dam-angling **fishery** from experienced fisheries technicians. The questionnaire contained two parts: (1) open-ended questions aimed at gathering detailed information on methods and equipment that were used **successfully**, and (2) a **survey** to rate components of the **fishery (1=excellent through 5=poor)** to **identify** areas **needing** improvement. The results of the questionnaire are summarized here.

Locating Northern Squawfish

To detect northern squawfish concentrations at dams, technicians utilized the following methods and cues:

- Previous knowledge of different sites at dams.
- Communication with other dam anglers and crews.
 - Data summaries and feedback provided by project **staff**.
 - Monitoring predator activity of the **gulls** and northern **squawfish**.
 - Random fishing (prospecting) of different sites at dams.
- Sites having artificial light at night.
- Water conditions.

Changing water conditions at dams were identified by technicians as being particularly important **in** locating concentrations of northern **squawfish**. Specifically, technicians found catch rates of northern **squawfish** to be high in **tailrace** areas near **turbine** boils and back-eddies.

Catching Northern Squawfish

Equipment

Crews used a variety of rods, reels, lines, and baits with varying success (Appendix Table B-1). The majority of technicians used 7- and 8-foot fishing rods. The rigors of this fishery require that reels be extremely durable, and the majority of the reels **performed** well (**Appendix**

Scheduling

Technicians agree catch rates of northern **squawfish** are better during night and early morning hours and schedules should encompass these periods. Specific recommendations concerning schedules were:

- Crews fish additional hours from Mid-June to Mid-July when the “bite is on” to maximize catch. This includes increased weekend scheduling.

Go to split-shifts toward the end of the dam-angling season when catch rates begin to decline; the first **shift** lasting from sundown to midnight, and the second **shift** from approximately 3 a.m. to 8 a.m.

- Begin season earlier on Snake River dams to improve catch rate.
- Work during periods of low tide at Bonneville **Dam**, at which time catch rates were observed to be relatively high by anglers at that darn.

Reducing Incidental Catch

To reduce incidental catch even **further**, supervisors and technicians with past dam-angling experience have suggested:

- Not fishing in forebay areas at some dams.
Better supervision and training of inexperienced technicians.

Alternative Fisheries

Technicians recommended several alternative fisheries for northern **squawfish**. **Longlining** was suggested as an effective way to remove northern **squawfish from tailrace** areas. Also, an organized effort to render the northern squawfish incidentally caught by treaty salmon fishermen may result in the removal of large numbers of northern squawfish. The number of northern **squawfish** in gill-net catches, and traditional hoop nets and dip nets fished from **scaffolds**, is high during the spring and late August through September. Currently, northern squawfish caught by these methods are not eligible for reward in the sport-reward program. Technicians believe that if there were a reward for these **fish**, more northern squawfish might be recorded and accounted for under the Columbia River Northern Squawfish Management Program.

Conclusions

We believe that the information gained from the technician questionnaire can improve dam-angling effectiveness. Based on the **information** provided by technicians, we will work to:

Facilitate **information** exchange between project **staff and** crews regarding **successful** sites, times, baits, and methods.

Provide advanced information regarding tide, spill, and turbine schedules to each crew.

- Work with crews to set schedules that will be most productive.
- Investigate other opportunities to remove northern squawfish.
- Continue to solicit comments from technicians to improve existing and **future** fisheries.

Appendix Table B-1. Evaluation of dam angling equipment used by technicians in 1994.

| Equipment | Make/Model | Recommendations For Use |
|-----------|---|---|
| Rods | Daiwa Black Widow | All models recommended |
| | Shakespeare Ugly Stik | 7 ft. rods better suited for bank fishing and boat angling. |
| | Bass Pro Shop Power Stick | 8 ft. rods cast more efficiently and do not rub fishing line against dam when reeling NSF to the top of the dam decks. |
| Reels | FenWick | Preferred , withstands rigors of fishery; Crank assembly lacks spring that fatigues in other reels. |
| | Penn | Not recommended, lacks power when reeling up to dam decks |
| Line | DuPont XT Solar | Highly visible, preferred when working at night. |
| | Spectra Spiderwire | Lack of stretch preferred for high velocity conditions. |
| | Berkley Trilene DuPont Stren | Good for all-around use. |

REPORT D

Site-Specific Removal of Northern Squawfish Aggregated to Feed on Juvenile Salmonids in the Spring in the Lower Columbia and Snake Rivers Using Gill Nets and Trap Nets

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1994 Annual Report

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ABSTRACT

As part of a site-specific fishery, small-meshed gill nets and mobile **Merwin** traps caught 9,024 predator-sized (≥ 250 mm fork length) northern **squawfish** (*Ptychocheilus oregonensis*) from areas where they concentrate to feed on hatchery-released juvenile **salmonids** (*Oncorhynchus* spp.) in the lower Columbia and Snake rivers. Most of these fish were caught in gill nets (99.9%) and at locations in Bonneville Pool (98.5%). **Merwin** traps were ineffective (total catch of predator-sized northern squawfish = 6), despite the placement of traps in areas where gill-net catches of northern squawfish were high. The mouth of the **Klickitat** River was the most productive location fished in 1994 in terms of both total gill-net catch (6,253) and catch rate (catch-per-net-hour 10.1), followed by three other locations in Bonneville Pool (**Drano** Lake, Wind River, and Spring Creek). The most productive locations outside Bonneville Pool were the mouths of the **Umatilla** and Clearwater rivers, with a combined gill-net catch of 86 predator-sized northern squawfish and catch-per-net-hour of 1.1. Gill nets caught larger predators (average fork length = 410.4 mm), whereas **Merwin** traps were less size-selective (average fork length = 233.4 mm). The total incidental catch for both gill nets and **Merwin** traps was 5,876 fish, with suckers (*Catostomus* spp.) being the predominate species caught in gill nets, and salmonids (mostly juveniles) in **Merwin** traps. Innovations to **Merwin** traps to minimize impacts to juvenile

salmonids were developed and tested **successfully**. Further developments and changes to the **site-specific** fishery are recommended to improve our efficiency and productivity.

INTRODUCTION

In 1990, the Columbia River Northern Squawfish Management Program was implemented to reduce predation by northern squawfish (*Ptychocheilus oregonensis*) on **outmigrating** juvenile **salmonids** (*Oncorhynchus* spp.) in the lower Columbia and Snake rivers. The program goal is to sustain a 10-20% annual exploitation rate on predator-sized (≥ 250 mm fork length) northern **squawfish**, which over several years may result in a 50% or greater reduction in predation on juvenile **salmonids** (Rieman and Beamesderfer 1990). Various predator-control fisheries were implemented as part of the Squawfish Management **Program**, and **after** three years it was determined that **further** development of management alternatives was required to reach the desired exploitation rate.

In 1993, the Columbia River Inter-Tribal Fish Commission (**CRITFC**) and **Yakama** Indian Nation (YIN) investigated a site-specific predator control fishery that used small-meshed gill nets to remove northern squawfish from areas where they concentrate to feed on hatchery-released juvenile **salmonids** (Collis et al. 1995a). We hypothesized that by targeting **feeding** concentrations of northern **squawfish**, we would effectively remove large numbers of mostly predator-sized fish from areas where predation rates are **high**, thereby maximizing the survival benefits to **out-migrating** juvenile **salmonids** accruing from our fishing efforts. Furthermore, we believed that the timing and methodology of the proposed site-specific fishery would minimize incidental impacts to both juvenile and adult **salmonids**, particularly stocks listed as threatened or endangered.

Our 1993 results suggested that a site-specific **fishery** targeting northern squawfish near hatchery-release points in the spring could be productive, while keeping incidental impacts to **salmonids** to a minimum (Collis et al. 1995b). Catch rates of predator-sized northern **squawfish** more than doubled from before to after release at three locations where hatchery salmon were released in Bonneville Pool (Collis et al. 1995a). Northern squawfish caught **after** the release of juvenile **salmonids** had a significantly higher frequency of occurrence and mean number of juvenile **salmonids** in their diet compared to fish caught before release (Collis et al. 1995a). The average length of fish captured in the site-specific fishery was greater than in all other predator control fisheries in 1993, with the exception of dam angling (Wink and Ward 1995). Our data suggest **that** site-specific 'removal of northern squawfish concentrated near hatchery release points could increase the current exploitation rate of northern squawfish. Furthermore, by targeting feeding concentrations of northern **squawfish**, this fishery has the advantage of removing larger predators from areas where predation rates on juvenile **salmonids** are high.

We investigated the step-wise implementation of a site-specific fishery using small-meshed gill nets and mobile **Merwin** traps to locate and target for removal concentrations of northern

squawfish near hatchery-release points in the lower Columbia and Snake rivers. Our objectives were to (1) expand the site-specific fishery to additional locations where northern **squawfish** might concentrate to feed on hatchery-released juvenile **salmonids** and (2) test the **feasibility** of an integrated **sampling** plan that uses both small-meshed gill nets and mobile **Merwin** traps to remove predator-sized northern squawfish from these areas, while minimizing impacts on **salmonids**.

METHODS

In 1994, three boat crews sampled at night in areas between the mouth of the Wind River and the head of Lake **Wallula (McNary Pool)** on the Columbia River, and the mouth of the ClearWater River on the Snake River (Figures 1 and 2; Table 1). Additionally, a separate crew operated a mobile **Merwin** trap in the cul-de-sac at The **Dalles Dam (Figure 2)**. Sampling was conducted where northern squawfish were expected to concentrate to feed on juvenile **salmonids**, specifically below hatchery release points, near dams, and near the mouths of tributaries. The National Marine Fisheries Service (**NMFS**) Section 7 permitting process delayed commencement of this fishery for approximately 1.5 months. The ensuing season lasted **from** mid-April through early June, when operational criteria established to minimize impacts to **salmonids** were reached (i.e., **A.5.c.** and **A.5.d.**, see Appendix A).

Tribal technicians were assisted by student volunteers enrolled in a cooperative education program at Mt. Hood Community College. Three volunteers worked one night a week for the duration of the season for college credit and work experience in fisheries science.

Sampling Design

An integrated sampling plan used small-meshed gill nets **while** mobile **Merwin** traps (Figure 3; for specifications see Mathews et al. 1991) were investigated as a way to increase the efficiency and productivity of the site-specific fishery. We hypothesized that **Merwin** traps would catch a greater number of northern squawfish per-unit-effort than small-meshed gill nets if deployed where these predators were concentrated (for discussion of **Merwin** trap effectiveness, see Lynch 1993). The integrated sampling **plan** involved three major steps:

1. Use current hatchery-release **information** and existing data on the seasonal patterns of northern squawfish density and abundance to construct a general **sampling** schedule (e.g., locations and times).
2. **Set** small-meshed gill nets (8 **ft** deep x 150 **ft** long constructed from **25-ft** panels with the repeating mesh size sequence: 2" and 13/4" bar measures) in these locations to find local concentrations of northern **squawfish**.

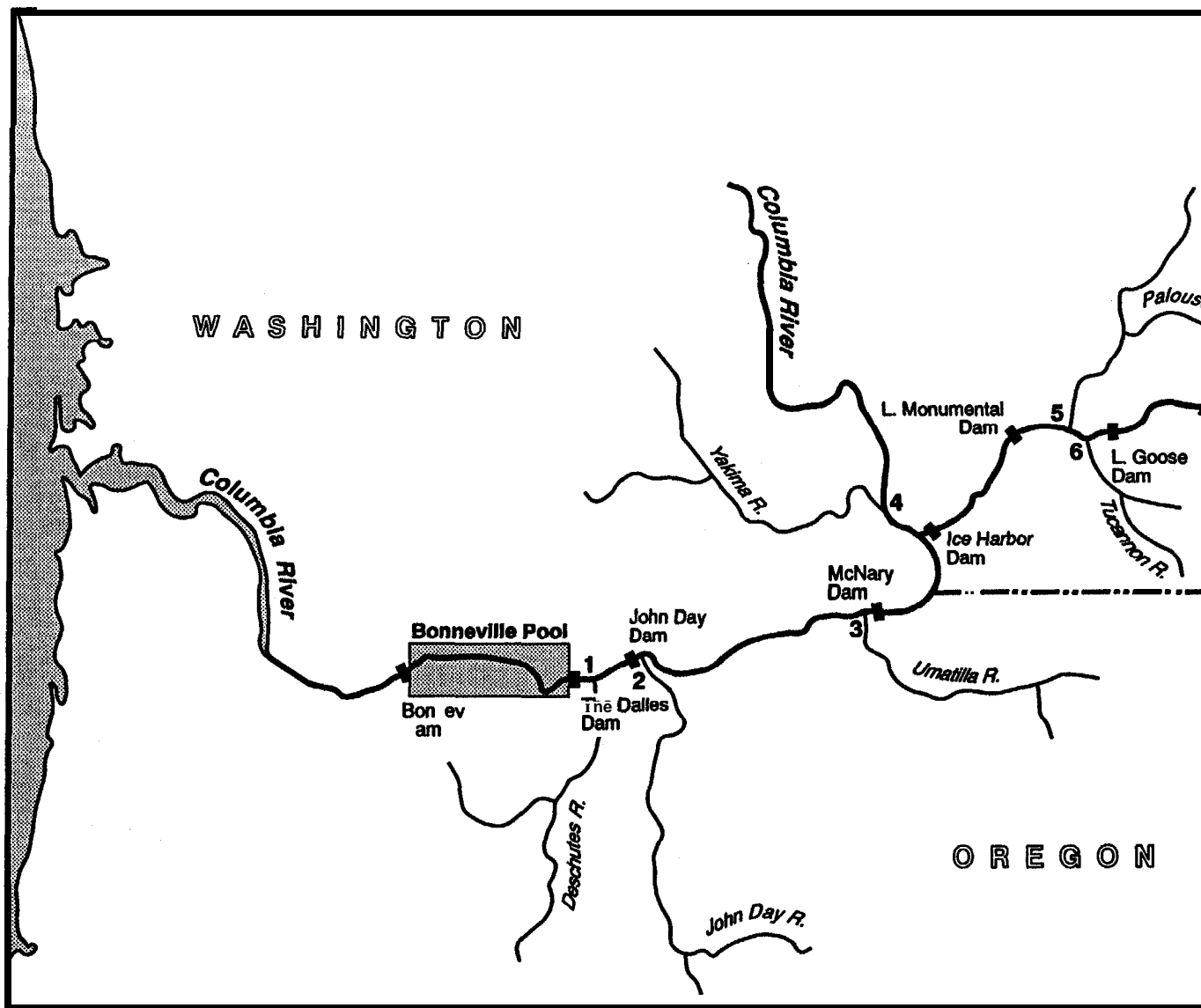


Figure 1. Sampling locations above Bonneville Pool (see **Figure 2-2** for locations in Bonneville Pool), 1994. Locations are: 1 = **Miller Island**; **River**; 3 = **Umatilla River**; 4 = **Yakima River**; 5 = **Lyons Ferry**; 6 = **Tuc** and 7 = **Clearwater River**.

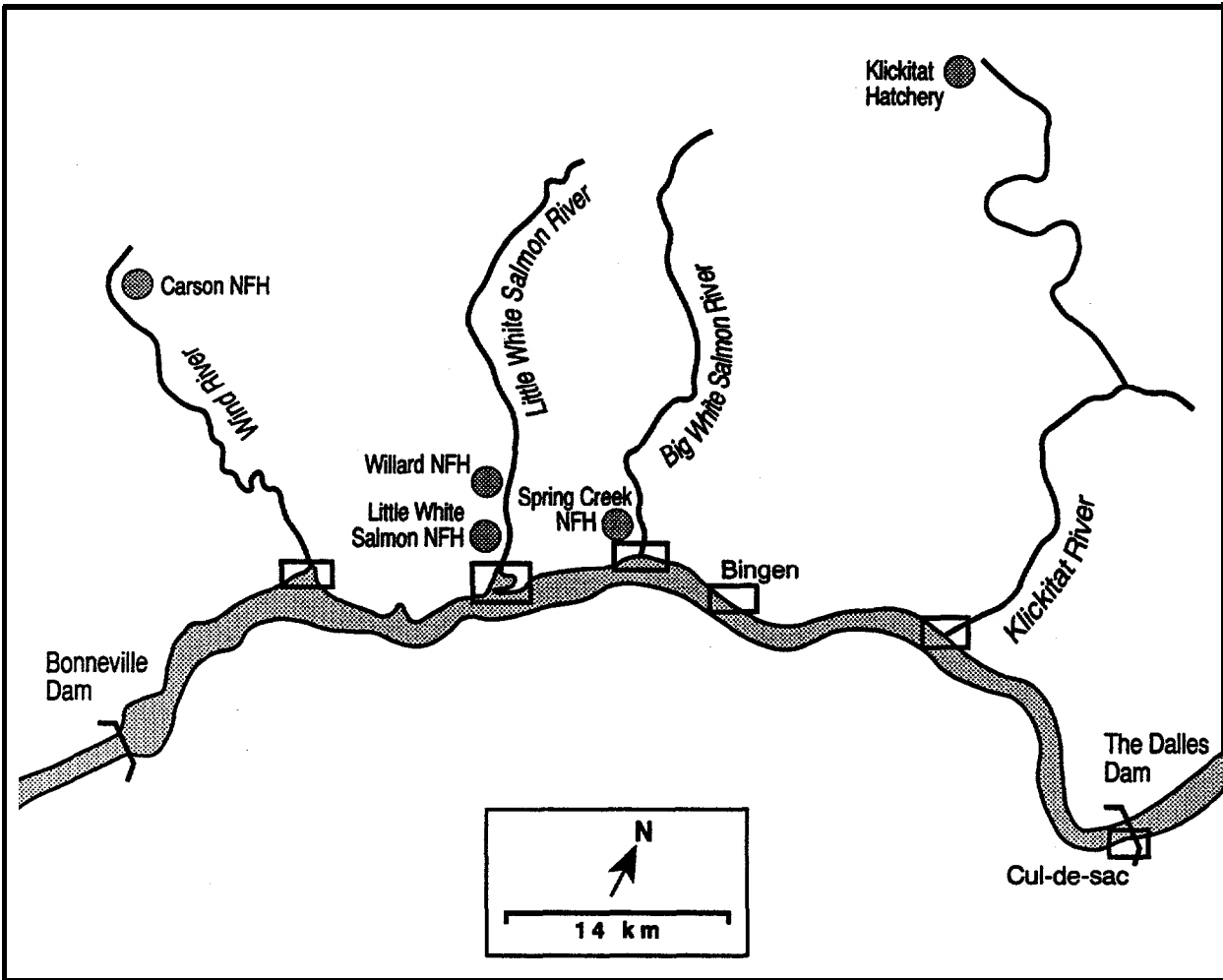


Figure 2. Sampling locations (shown in boxes) in Bonneville Pool, 1994. Locations are (left to right): Wind River; Drano Lake; Spring Creek; Bingen; Klickitat River; and the Cul-de-sac at The Dalles Dam.

Table 1. Distribution of site-specific fishery effort at locations on the Columbia and Snake rivers in 1994.

| Location | River mile | Dates worked - (crew nights fished) | Crew ^a |
|------------------------------|---------------|--|---------------------|
| Bonneville Pool | | | |
| Wind River | 154 | 4/25 - 5m4 (7) | CRITFC ^b |
| Drano Lake | 162 | 4/19-5/31 (31) | CRITFC ^c |
| spMg creek | 167 | 4/26, 5/19 (2) | CRITFC |
| Bingen | 172 | 4123 (1) | CRITFC |
| Klickitat River | 180 | 4/21 - 6/06 ^d (43) | CRITFC ^c |
| The Dalles Dam (cul-de-sac) | 192 | 5/05 - 5/23 (5) | CTWS |
| The Dalles Pool | | | |
| Miller Island | 205 | 6/08 (1) | CRITFC |
| John Day Pool | | | |
| John Day River | 218 | 6/02 (1) | YIN |
| Umatilla River | 289 | 4120,5131 (2) | YIN |
| McNary Pool | | | |
| Yakima River | 327 | 4/08 - 5/16 (6) | YIN |
| Lower Monumental Pool | | | |
| Lyons Ferry | 59 | 4/21 (1) | NPT |
| Tucannon River | 62 | 4/20 (1) | NPT |
| Little Goose Pool | | | |
| Lower Granite Dam (tailrace) | 107 | 6/06 - 6/09 (4) | NPT |
| Lower Granite Pool | | | |
| Clearwater River | 139 | 5/04 - 6m1 (5) | NPT |

^a CRITFC = Columbia River Inter-Tribal Fish Commission; CTWS = Confederated Tribes of Warm Springs Reservation, YIN = Yakama Indian Nation; NPT = Nez Perce Tribe.

^b CRITFC crew assisted by YIN crew.

^c CRITFC crew assisted by YIN and NPT crews.

^d Crew training occurred on one night in March (3/09). Roughly, 3 hr of gill-net sampling were done and those results are included in subsequent data summaries.

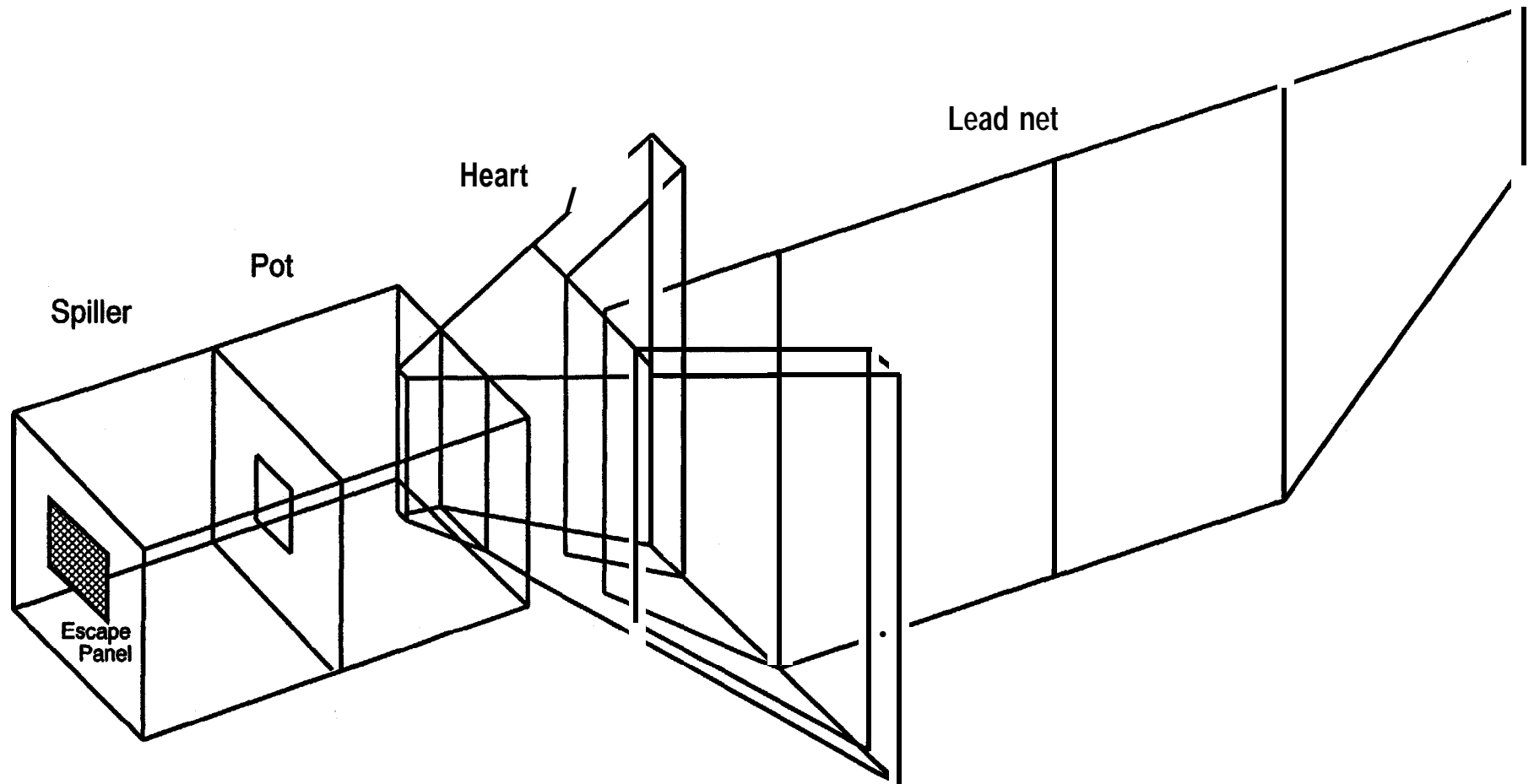


Figure 3. **Diagram** of the mobile **Merwin** traps used in the site-specific fishery in 1994. Escape panel constructed from 2-in (bar measurement) monofilament **gillnetting** affixed to the spiller just below the water line using velcro.

3. Deploy **Merwin** traps when and where gill-net catches are **high**, while, through **careful** monitoring, minimizing the incidental catch of other species, particularly **salmonids**.

Merwin traps were deployed when (1) ≥ 10 northern **squawfish** per-net-hour were caught in three consecutive gill-net sets (approximately 45 midset) and (2) gill-net catches of **salmonids** did not exceed operational criteria established for **gillnetting** (see **Appendix A**). An exception was the cul-de-sac at The **Dalles Dam**, where **Merwin** traps were deployed without previous gill-net sampling. **Merwin** traps were checked once every three hours. Concurrent gill-net sampling at other locations and sites within a location supplemented the **Merwin** trap sampling and was used in decisions to either relocate or discontinue trapping efforts. More effort was devoted to **gillnetting** when **Merwin** trapping proved to be relatively unproductive.

To minimize potential impacts of **Merwin** traps on juvenile **salmonids**, an escape panel of a larger mesh size (2" bar measure) was sewn into the splicer (Figure 3) so that juveniles could escape the trap without having to be removed with a dip net. The impacts of gill nets to juvenile **salmonids** were negligible because the mesh size was large enough that juveniles could easily pass through the net. Additional information on the specifications of the gear used in this study and handling of the incidental catch can be found elsewhere (gill nets: **Collis et al. 1995b**; mobile **Merwin** traps: **Iverson et al. 1992**; also see **Appendix A** for Operational Criteria).

Data Collection and Analysis

We enumerated the catch of each net and trap and measured fork length from a random **sample** of up to five northern squawfish from each net or trap. Unless otherwise noted, subsequent data summaries and analyses include only predator-sized (≥ 250 mm fork length) northern **squawfish**. We compared catch and catch rate (**catch-per-gillnet-hr** or trap-hr; **CPUE**) for different gears, areas (e.g., pools, locations), and time periods (e.g., **month**, **diel** period, before and after release). Incidentally caught fish were identified and immediately released back into the river. Incidentally caught game fish were assigned one of three condition codes at the time of release: (1) minimal injury, certain to survive; (2) moderate injury, may or may not survive; or (3) dead, nearly dead, or certain to die. Additionally, **all salmonids** caught were identified as either juvenile or adult and examined for external marks or fin clips. Also, we gathered specific **information** on the condition of each **salmonid** at release (i.e., Was the fish bleeding?, Did the fish free itself from the net?, How was the fish caught in the net?).

Statistical comparisons are by Student t-test (t) and Kendall rank correlation (**r_s**). **All p** values are two-tailed. Means are expressed as **$\bar{X} \pm SE$** .

RESULTS AND DISCUSSION

Northern Squawfish Catch

Distribution of Catch and Effort

In 1994, we caught a total of 9,159 northern **squawfish** (Table 2). The majority (99.4%) of these fish were caught in **gill** nets and most (**98.5%**) were predator-sized (≥ 250 mm fork length). Overall, **gill** nets were fished for 1,375 net hours and caught 9,018 predator-sized northern **squawfish**, for a seasonal catch-per-net-hour (**CPUE**) of 6.6. **Merwin** traps were ineffective despite **placing** the traps in areas where gill-net catches of northern **squawfish** were high (see Gear Effectiveness). Mobile **Merwin** traps caught only six predator-sized northern **squawfish** in 67.4 **hr** of trap **effort**, for a seasonal catch-per-trap-hour (**CPUE**) of 0.1. Unless otherwise noted, data summaries that follow refer to gill-net catches of predator-sized northern squawfish.

Bonneville Pool was the most productive of the seven pools we fished in both total catch (**Figure 4**) and CPUE of northern **squawfish** (**Figure 5**). In Bonneville Pool, we caught 8,884 northern **squawfish** in 1,128 **hr** of effort, for a seasonal **CPUE** of 7.9. Of the remaining pools, Lower Granite and John Day were the most productive (**Figures 4 and 5**), with a **combined** catch of 96 northern **squawfish** in 96.5 **hr** of effort, for a seasonal **CPUE** of 1.0. The late stint, **high** flows, and regional concerns about incidental impacts to salmon at some locations precluded a thorough investigation of potentially productive sites outside of Bonneville Pool. Generally, **gillnetting** effort was distributed in **pools** and at locations that were most productive based on relative catch rates (**Figure 5**).

The mouth of the **Klickitat** River was the most productive location that we fished in 1994 (**CPUE** = 10.1), followed by three other locations in Bonneville Pool (Table 2). The mouth of the **Umatilla** River (**CPUE** = 1.2) was the most productive location outside of Bonneville Pool, followed by the mouths of the Clearwater and John Day rivers (Table 2). There are several possible explanations for the higher catch rates of predator-sized northern **squawfish** at locations within Bonneville Pool relative to locations in other pools. First, it is likely that differences in the total number of **hatchery** fish released within a pool and at a location **affect** catch rates (Table 3). In 1994, approximately 22.6 million juvenile **salmonids** were released at locations we sampled in Bonneville Pool, compared to 11.9 million fish at **all** locations combined outside Bonneville Pool (Table 3; Fish Passage Center, unpublished data). Furthermore, we found that catch rates of northern **squawfish** are positively correlated with the total number of hatchery fish **released**¹ at a given location ($r_s = 0.62$, $p = 0.02$; **Figure 6**). Second, although there were more releases at locations worked outside Bonneville Pool, most of those were small (81% of hatchery releases were <500,000 juvenile **salmonids**) compared to the releases at locations worked in Bonneville

¹ Does not include numbers of fish released **after** the closing of the fishery (June 9).

Pool (37% of hatchery releases were < 500,000 juvenile **salmonids**; Table 3). Third, higher flow velocities at some sampling sites in upriver locations, as compared to Bonneville Pool, sometimes precluded or limited gill-net sampling and could have reduced residence time **of juveniles** at those sites. Finally, due to limited time and resources, we were unable to thoroughly investigate locations outside Bonneville Pool.

May was the most productive month in both total catch and CPUE of northern **squawfish** (Figure 7). We expect that sampling in April would have been more productive if the fishery had not been delayed until April 192. Roughly 70% of the April hatchery releases occurred before our sampling began at those locations (Table 3). Delays in the commencement of this fishery eliminated all sampling in **March**, with the exception of roughly 3 hr of crew training at the **Klickitat** River on March 9. Catch rates were high during this training period (**CPUE** = 11.1) indicating that March also might have been very productive.

Operational criteria (see Appendix A), established to minimize impacts to **salmonids**, were reached (i.e., **A.5.c.** and **A.5.d.**, see Appendix A) in early June (June 8, 1995), which ended the fishery despite high catch rates of northern **squawfish** at some locations (e.g., **CPUE** = 7.9 at the **Klickitat** River in June). We estimate that approximately 6,000 more predator-sized northern squawfish might have been caught given a timely start of the fishery and less restrictive operational criteria.

The timing and duration of elevated catch rates of northern **squawfish** in a sampling location appear to be directly related to the release date and subsequent residence time of hatchery-released fish in the area (**Collis et al. 1995a**). To test this hypothesis, two locations (**Drano Lake, Klickitat River**) were sampled throughout a release period (i.e., **before, during,** and after release) in 1994. There is some evidence to support this hypothesis, because catch rates peaked during or immediately following hatchery releases at those locations (**Figure 8**).

Catch rates of northern **squawfish** were highest at sunset and sunrise, when catch rates of adult **salmonids** were lowest (**Figure 9**). Operational criteria in 1994, established to minimize impacts to **salmonids**, required that our sampling end no later than one hour before sunrise (i.e., **A.2.**, see Appendix A). However, the dawn time period³, seems to be the most effective in catching northern **squawfish** and avoiding **salmonid** by-catch (**Figure 9**; see Recommendations for suggested changes to criteria).

²Sampling at the mouth of the **Yakima** River, which is not defined as critical **habitat** for listed species, began earlier (April 8), before the issuance of a biological opinion by the National Marine **Fisheries** Service.

³Sampling during this time period occurred because equipment (primarily boat) failure or high catch rates made it impossible to remove the nets from the water any earlier.

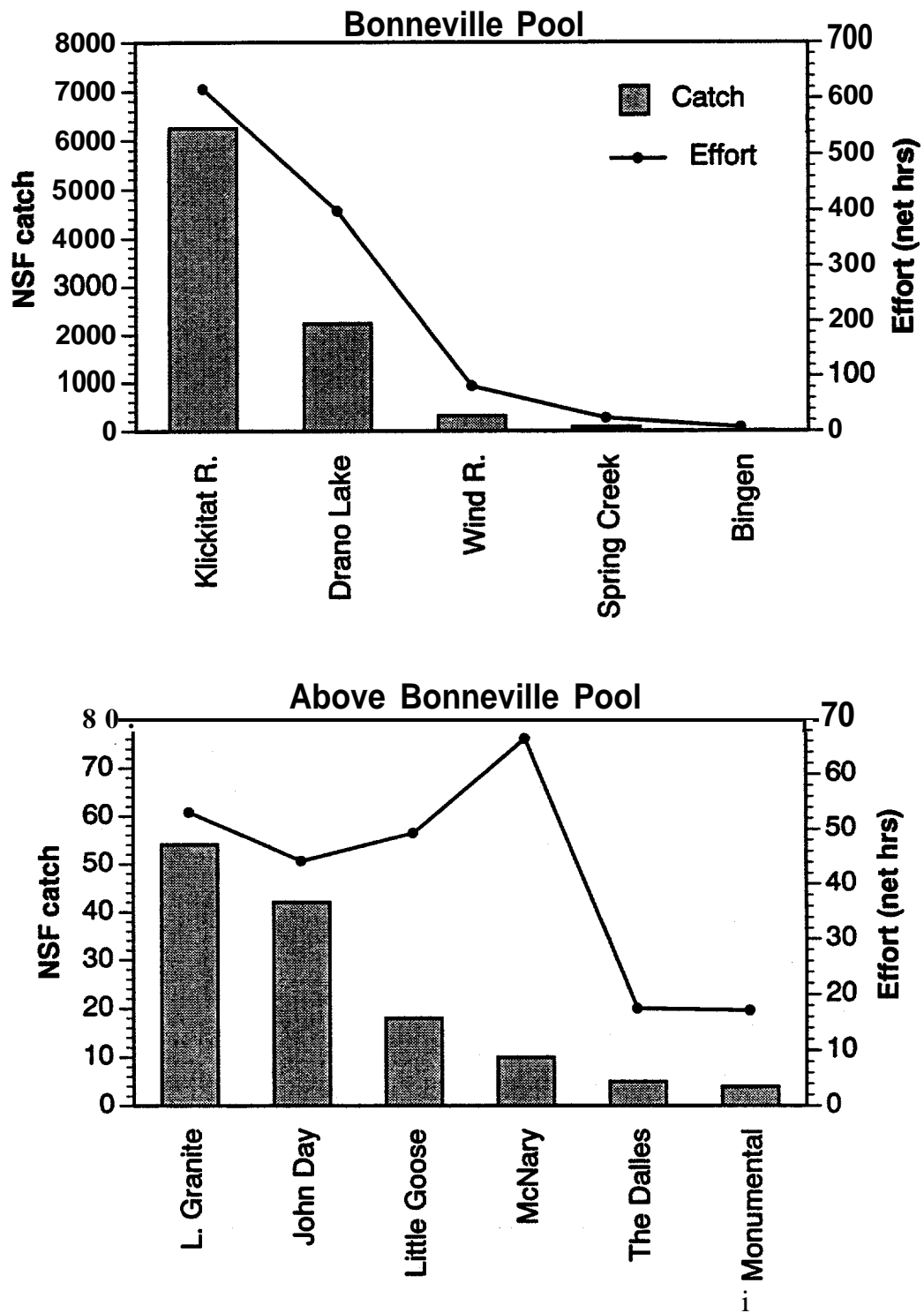


Figure 4. Northern squawfish (NSF) gillnet catch and effort at locations in Bonneville Pool and in pools above Bonneville Pool in 1994. Locations and pools arranged in order of highest to lowest catch (left to right).

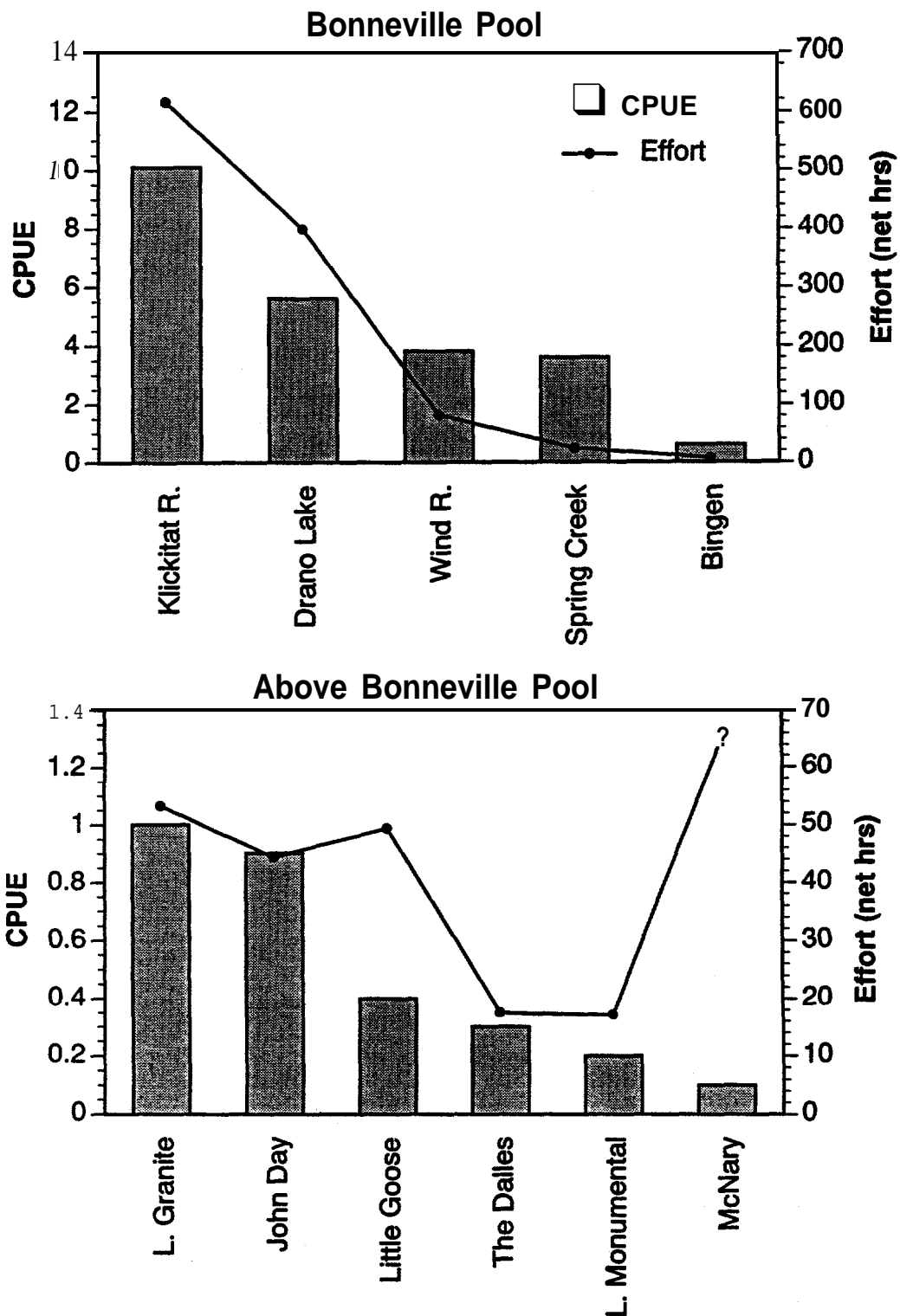


Figure 5. Northern **squawfish** gillnet catch-per-net-hr (CPUE) and effort at locations **in** Bonneville Pool and **in** pools above Bonneville Pool **in** 1994. Locations and pools arranged **in** order of highest to lowest CPUE (left to right).

Table 2. Northern squawfish (NSF) catch, effort, and catch-per-unit-effort (CPUE) for Merwin traps and gill nets at locations on the lower Columbia and Snake rivers in 1994.

| Location | Merwin trap | | | | | Gill net | | | | |
|----------------|--------------------------|---------------------|------------------------|---------------------|-------------------|--------------------------|---------------------|---------------------|------------------------|-------------------|
| | Crew nights fished | Effort ^a | Sm NSF ^b | Lg NSF ^c | CPUE ^d | Crew nights fished | Effort ^e | Sm NSF ^b | Lg NSF ^c | CPUE ^d |
| Klickitat R. | 6 | 21.0 | 0 | 3 | 0 | 44 | 616.5 | 69 | 6,253 | 10.1 |
| Drano Lake | 3 | 9.9 | 0 | 0 | 0 | 31 | 399.1 | 9 | 2,231 | 5.6 |
| Wind R. | — | — | — | — | — | 7 | 81.6 | 0 | 32 | 3.8 |
| Spring Creek | — | — | — | — | — | 2 | 23.4 | 2 | 84 | 3.6 |
| Umatilla R. | — | — | — | — | — | 2 | 27.6 | 4 | 32 | 1.2 |
| Clearwater R. | — | — | — | — | — | 5 | 53.2 | 1 | 54 | 1.0 |
| John Day R. | — | — | — | — | — | 1 | 15.7 | 0 | 10 | 0.6 |
| Bingen | — | — | — | — | — | 1 | 7.1 | 0 | 4 | 0.6 |
| Lyons Ferry | — | — | — | — | — | 1 | 10.3 | 2 | 5 | 0.4 |
| L. Granite Dam | — | — | — | — | — | 4 | 49.3 | 0 | 18 | 0.4 |
| Miller Is. | — | — | — | — | — | — | 17.5 | 0 | 5 | 0.3 |
| Yakima R. | — | — | — | — | — | 6 | 66.5 | 0 | 0 | 0.1 |
| Tucannon R. | — | — | — | — | — | 1 | 6.8 | 0 | 0 | 0.0 |
| The Dalles Dam | 5 | 36.5 | 30 | 3 | 0.1 | — | — | — | — | — |
| TOTAL | 14 | 67.4 | 48 | 6 | 0.1 | 106 | 1,374.6 | 87 | 9,018 | 6.6 |

^a trap hr.

^b < 250 mm (fork length).

^c ≥ 250 mm (fork length).

^d CPUE for NSF ≥ 250 mm (fork length).

^e net hr.

Table 3. Hatchery releases of juvenile salmonids from April-June at locations on the lower Columbia and Snake rivers in 1994.

| Location | Pool ^a | Total number released (million) | Number of releases | Date(s) of release ^b | |
|---------------|-------------------|------------------------------------|-----------------------|--|----------------------|
| | | | | April | May |
| Wind R. | OO | 2.1 | 2 | 14 , 22- | |
| Drano Lake | BO | 8.2 | 6 | <u>14, 14, 14</u> | 19 |
| Spring Creek | BO | 7.6 | 2 | 14 | <u>19</u> |
| Klickitat R. | BO | 9.5 | 10 | 11 , <u>15, 19</u> , 25-, 26-, 29 | <u>17, 3</u> |
| Umatilla R. | JD | 4.8 | 10 | 1-, 4 , 5-, 11, 13, 15, 19 | 12, <u>20</u> |
| Yakima R. | MC | 2.6 | 3 | 7- | 1, <u>15</u> |
| Lyons Ferry | LM | 0.7 | 2 | 18 , 26- | |
| Tucannon R. | LM | 0.2 | 2 | 11-, 11- | |
| ClearWater R. | GR | 3.6 | 14 | 8, 9-, 13-, 18-, 18-, 18-, 18, 22, 25-, 29-, 29- | <u>2</u> , 3, |
| TOTAL | | | | | |

^aBO = Bonneville Pool, JD = John Day Pool, MC = McNary Pool, LM = Lower Monumental Pool, GR = Lower Granite Pool

^bDates followed by a "-" are volitional releases that began on the date listed. Dates in bold and underlined represent releases of >500,000

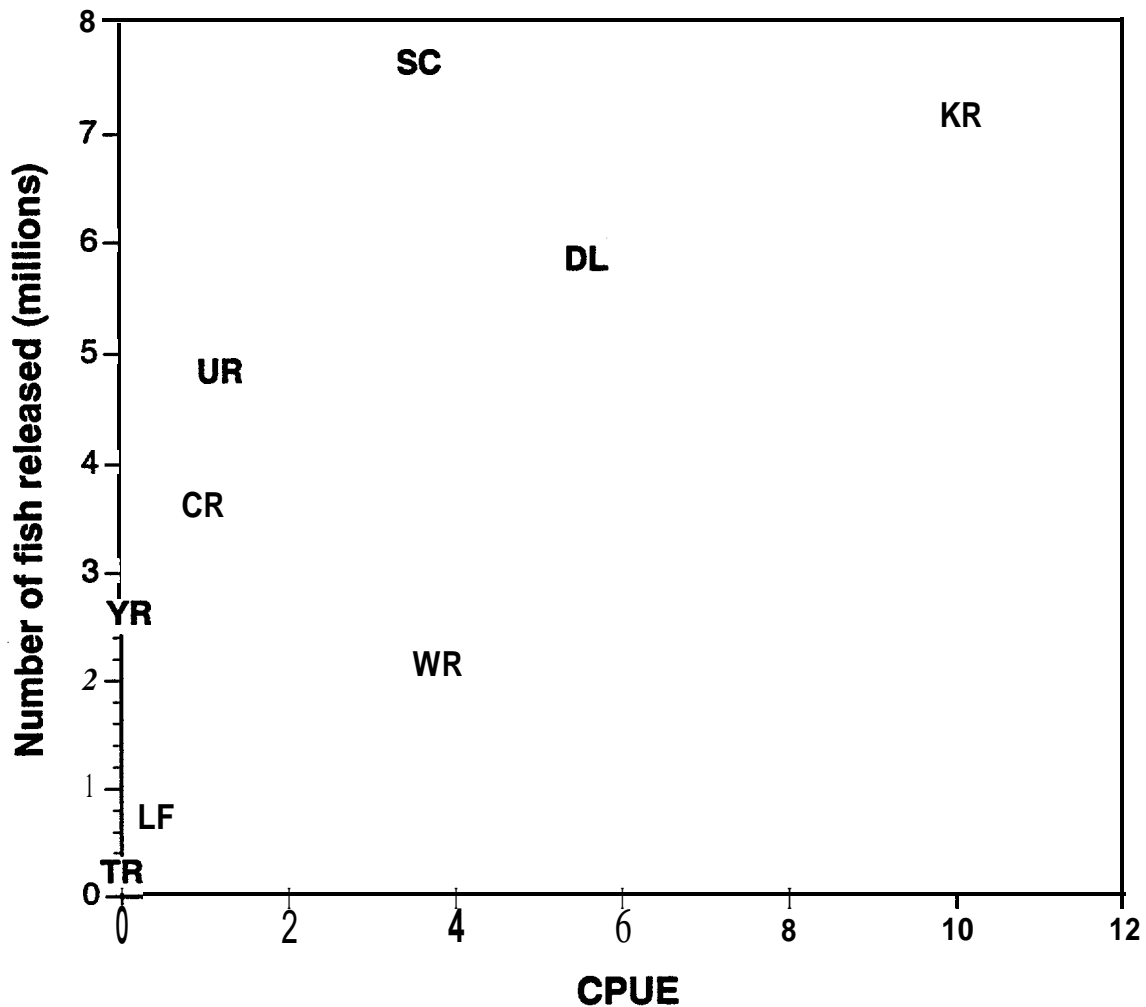


Figure 6. Catch-per-net-hr (**CPUE**) of northern squawfish in gillnets relative to the total number of hatchery-reared juvenile salmonids released at each location in 1994: **KR** = **Klickitat** River; **DL** = Drano Lake; **WR** = Wind River; **SC** = Spring Creek; **UR** = **Umatilla** River; **CR** = Clearwater River; **LF** = Lyons Ferry; **YR** = **Yakima River**; and **TR** = Tucannon **River**.

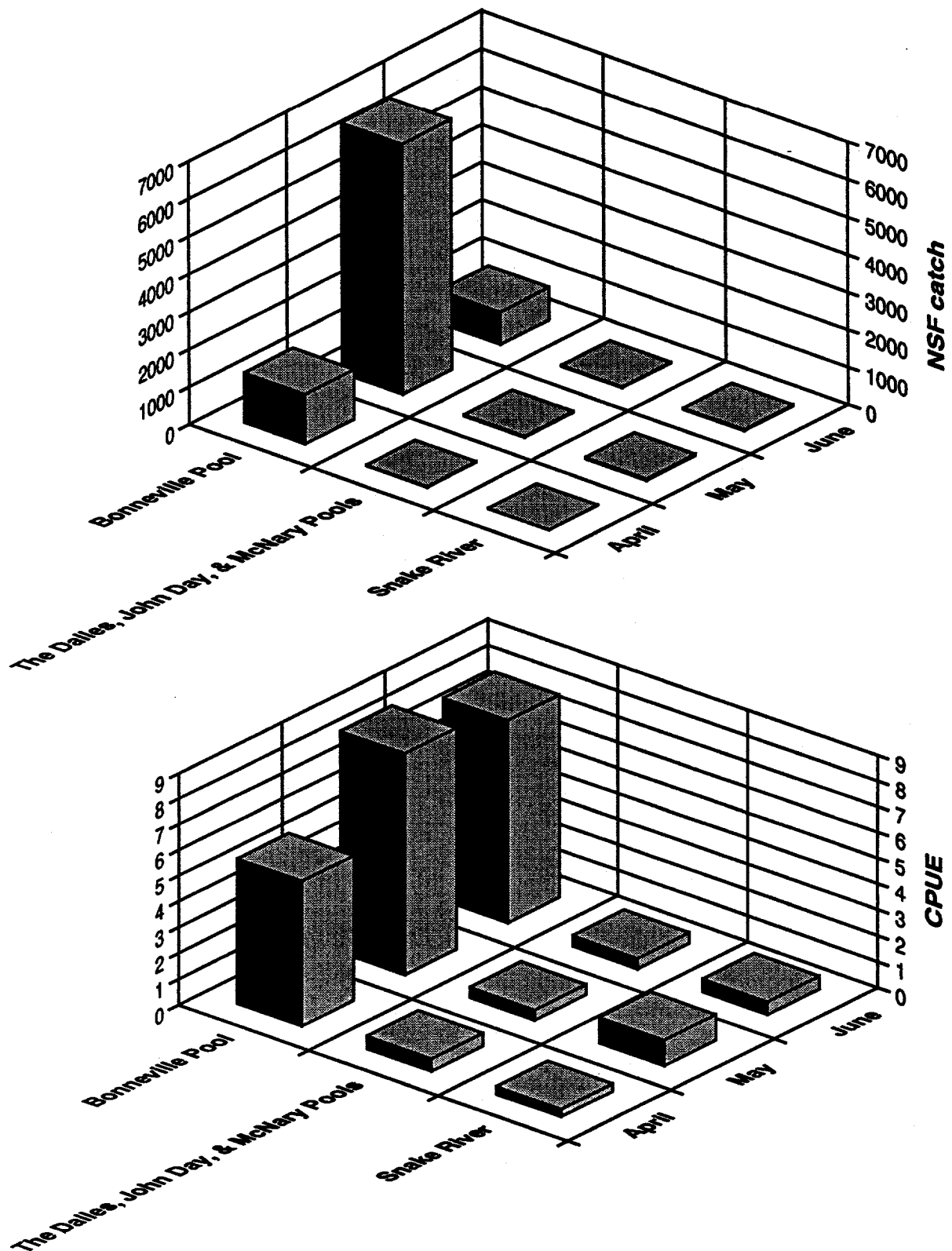


Figure 7. Monthly gillnet catch and catch-per-net-hr (CPUE) of northern squawfish (NSF) in: Bonneville Pool; The Dalles, John Day, and McNary Pools; and the Snake River in 1994.

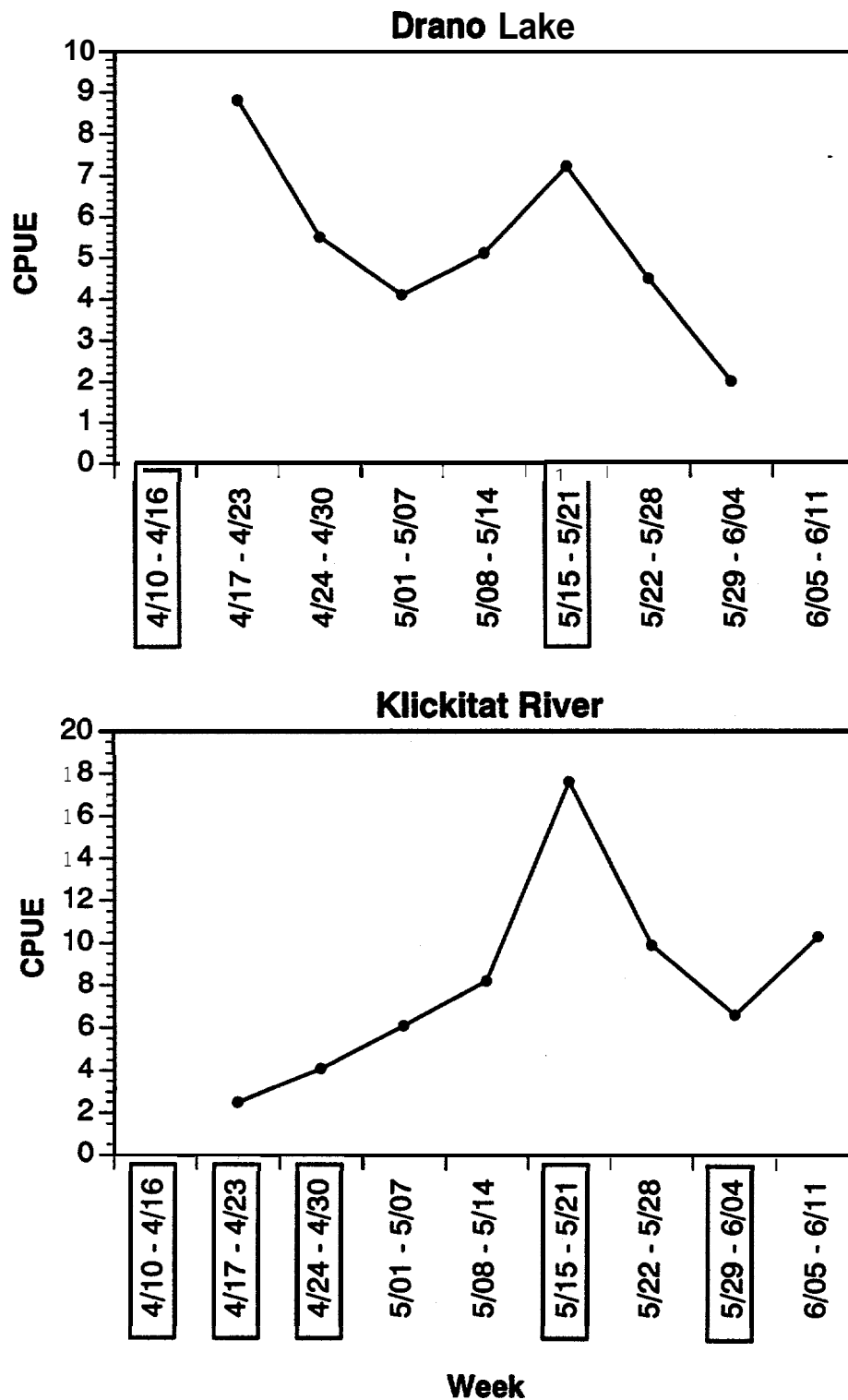


Figure 8. Weekly gillnet catch-per-net-hr (CPUE) of northern squawfish at **Drano Lake** and the **Klickitat River** in 1994. **Dates** shown in boxes represent weeks when hatchery-reared juvenile salmonids were released at that location.

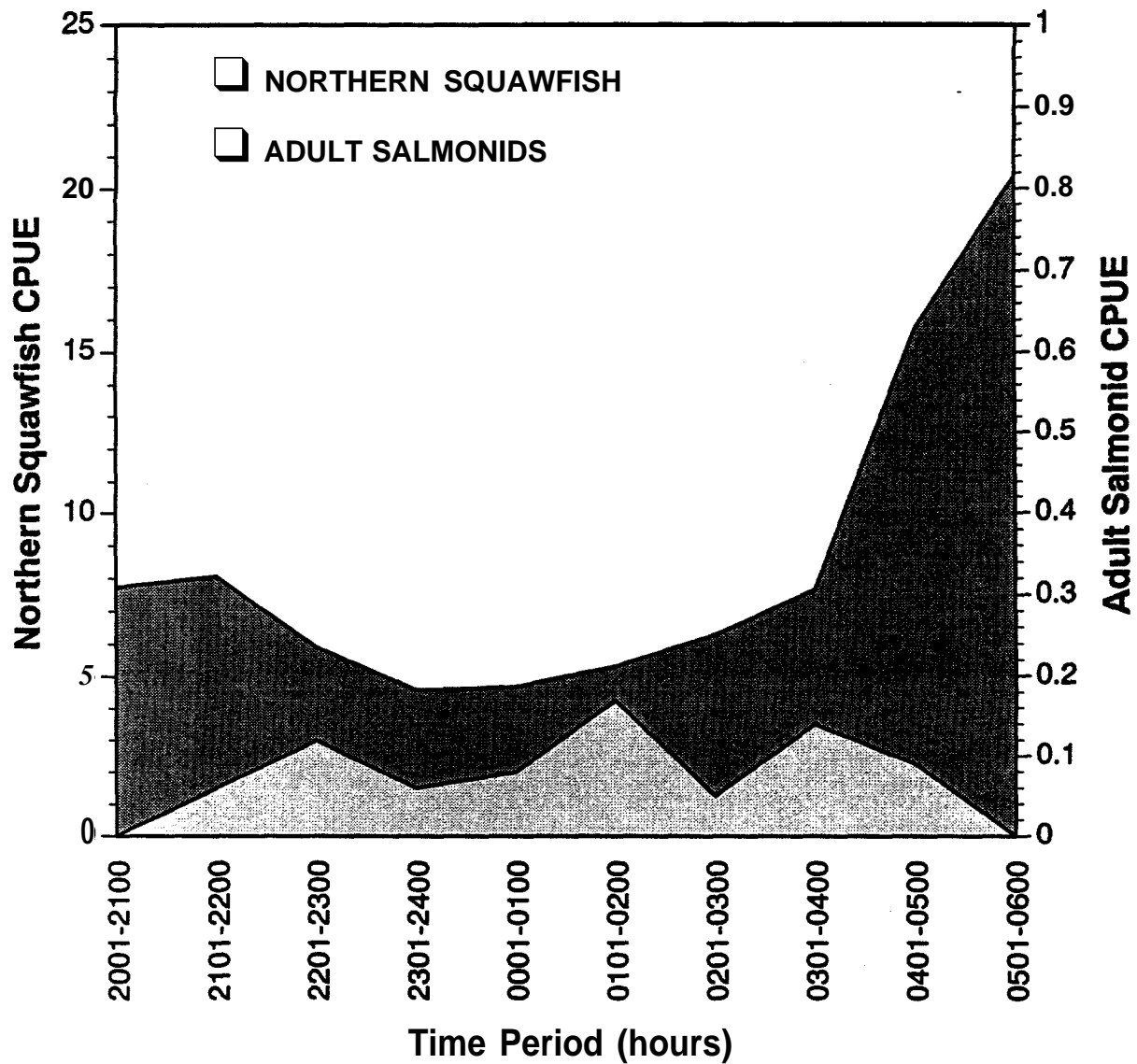


Figure 9. Catch-per-net-hour (CPUE) of northern squawfish and adult **salmonids in gillnets** during different time periods at all sampling locations in 1994. CPUE for earliest and latest time periods are based on a limited number of **gillnet** sets.

Gear Effectiveness

Small-meshed gill nets were more effective than mobile **Merwin** traps in this fishery for several reasons. First, the overall catch rate of northern **squawfish** with gill nets was considerably higher than with **Merwin** traps (Table 2). On seven nights when **Merwin** traps and gill nets were fished concurrently in the same sites, gill nets caught 653 predator-sized northern **squawfish** in 50.9 net hours of effort (**CPUE** = 12.8), compared to just one predator-sized northern squawfish caught in **Merwin** traps in 22.1 trap hours of effort (**CPUE** = 0.04).

Secondly, gill nets catch significantly larger (fork length) northern **squawfish** as compared to mobile **Merwin** traps (gill nets: $\bar{X} = 410.4 \pm 0.7$ mm, $n = 4,602$; **Merwin** traps: $\bar{X} = 233.4 \pm 7.6$ mm, $n = 30$, $t = 19.3$, $p = .0001$; Figure 10). In 1994, we improved the effectiveness of gill nets in catching larger **predator-sized** northern squawfish by eliminating the smallest mesh size (1 1/4" bar measure; Table 4) used in gill nets the previous year (**Collis** et al. 1995a). Furthermore, this change did not seem to negatively affect **CPUE** at the locations worked in both years (Table 4).

Finally, northern **squawfish** composed a greater percentage of the total catch in gill nets (62%) than they did in mobile **Merwin** traps (14%). This might be expected because **small-**meshed gill nets tend to target fish in the size range of predator-sized northern **squawfish**, whereas the **mobile Merwin** traps were less size-selective.

Past studies have shown that **Merwin** traps can be effective in catching northern squawfish in Columbia and Snake River reservoirs (**Lemier** and Mathews 1962; Sims et al. 1977; Mathews et al. 1992), particularly during the summer months when northern **squawfish** are presumed to be migrating to spawn. We hypothesized that **Merwin** traps could also be effective in catching northern squawfish in the spring if placed in areas where they are concentrated to **feed** on hatchery-released juvenile **salmonids**. Our data do not support this hypothesis. One possible explanation for this result might be that, while foraging, northern squawfish are less vulnerable to capture with **Merwin** traps than when they are migrating to spawn. Perhaps migrating **fish**, motivated to find a way around the lead net, can be led more easily into the trap than foraging fish, which may simply mill around and avoid the trap.

Incidental Catch

Species Composition

In 1994, 5,876 fish (39% of the total catch) were incidentally caught in gill nets and **Merwin** traps combined (Table 5). Incidentally caught species composed 38% and 86% of the total catch in gill nets and **Merwin** traps, respectively (Figure 11). Suckers (*Catostomous* spp.) were the most common incidentally caught species in gill nets, composing 69% of the incidental catch and 26% of the total catch (Table 5). **Salmonids** (mostly **juveniles**; see Salmonid By-Catch) composed the largest percentage of the total (40%) and incidental (47%) catch in **Merwin** traps (Table 5).

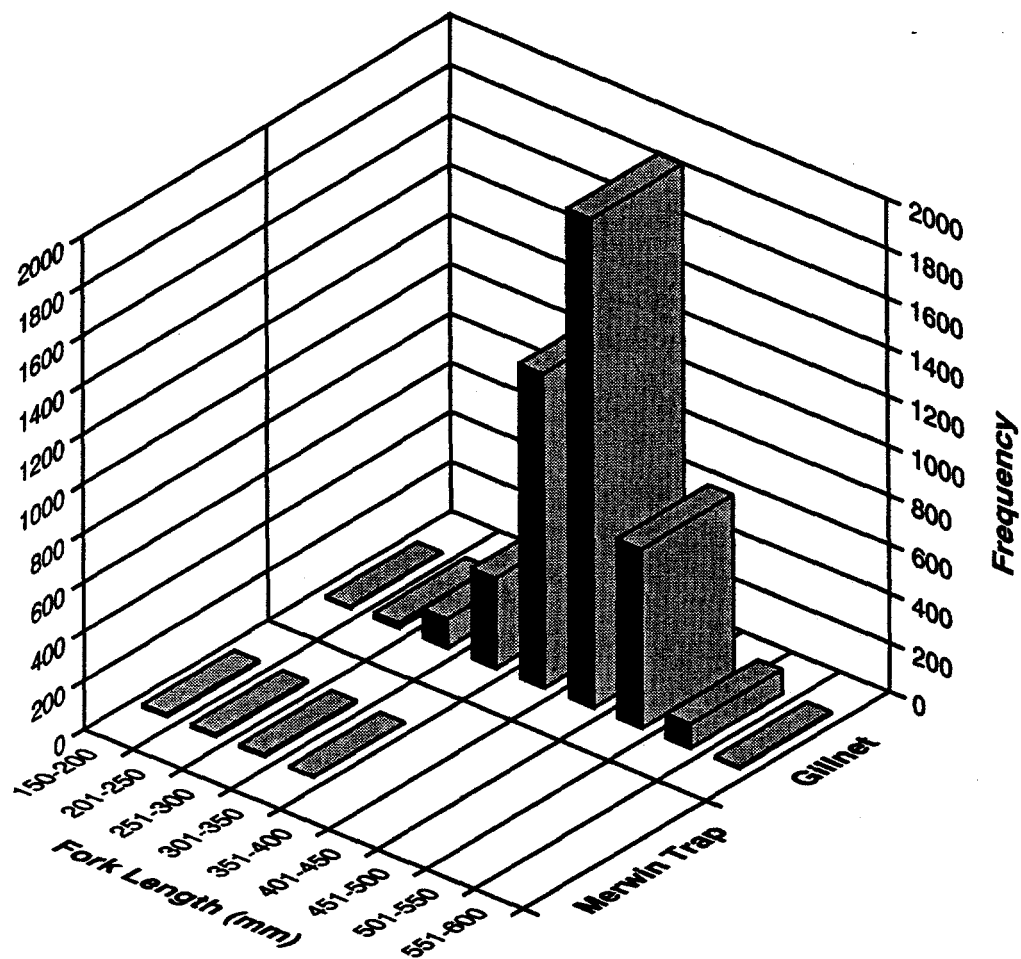


Figure 10. Size **distribution** of northern **squawfish** caught in Merwin traps and gillnets at all sampling locations in 1994.

Table 4. Comparisons of size (fork length) and catch rate (CPUE) of northern squawfish caught in gill nets having different mesh sizes in 1993 and 1994.

| Location | 1993 ^a | | | 1994 ^b | | |
|----------------|------------------------|---------------|-------------------|------------------------|----------------|-------------------|
| | Average length (mm) | predator-size | CPUE ^c | Average length (mm) | predator-sized | CPUE ^c |
| Wind River | 381.0 | 99.39 | 4.6 | 407.1 | 100.00 | 3.8 |
| Drano Lake | 375.9 | 98.75 | 6.0 | 424.4 | 99.60 | 5.6 |
| Spring Creek | 346.5 | 96.24 | 2.7 | 396.8 | 97.67 | 3.6 |
| Overall | 370.7 | 98.36 | 4.4 | 410.4 | 99.58 | 5.2 |

^a Gill nets were 8 ft deep x 150 ft long constructed from 25-ft panels with the repeating mesh size sequence: 2 in, 13/4 in, and 1 1/4 in bar measures.

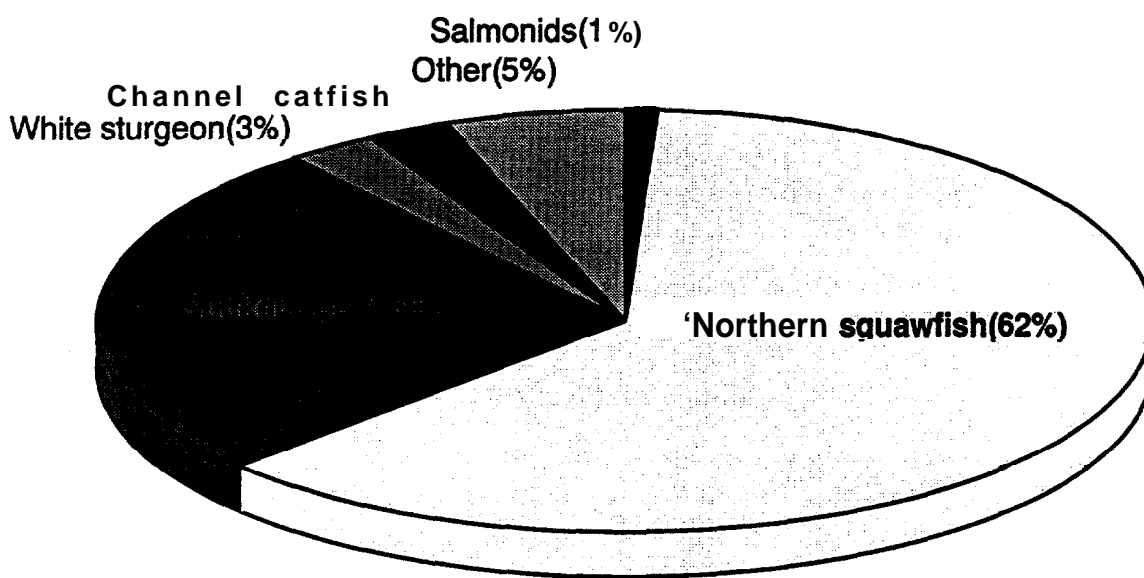
^b Gill nets were the same depth and length as in 1993; however, the smallest mesh size (1 1/4 in) was eliminated.

^c Catch-per-net-hour of predator-sized (≥ 250 mm fork length) northern squawfish.

Table 5. Species composition for site-specific gill-net and Merwin trap catches in 1994.

| Species | Gill net | Merwin trap | TOTAL |
|---|----------|-------------|-------|
| Northern squawfish* <i>Ptychocheilus oregonensis</i> | 9,105 | 54 | 9,159 |
| Incidental catch | | | |
| Sucker <i>Catostomus</i> spp. | 3,832 | 7 | 3,839 |
| White sturgeon <i>Acipenser transmontanus</i> | 401 | 0 | 401 |
| Channel catfish <i>Ictalurus punctatus</i> | 376 | 0 | 376 |
| Salmonids ^b <i>Oncorhynchus</i> spp. | 144 | 150 | 294 |
| Common carp <i>Cyprinus carpio</i> | 250 | 0 | 250 |
| Pearmouth <i>Mylocheilus caurinus</i> | 140 | 49 | 189 |
| Walleye <i>Stizostedion vitreum</i> | 98 | 0 | 98 |
| Chiselmouth <i>Acrocheilus alutaceus</i> | 47 | 28 | 75 |
| Redside shiner <i>Richardsonius balteatus</i> | 0 | 69 | 69 |
| Bass <i>Micropterus</i> spp. | 51 | 14 | 65 |
| Mountain whitefish <i>Prosopium williamsoni</i> | 46 | 0 | 46 |
| American shad <i>Alosa sapidissima</i> | 36 | 0 | 36 |
| Brown bullhead <i>Ictalurus nebulosus</i> | 23 | 0 | 23 |
| Pumpkinseed <i>Lepomis gibbosus</i> | 11 | 0 | 11 |
| Sculpin <i>Cottus</i> spp. | 2 | 3 | 5 |
| Crappie <i>Pomoxis</i> spp. | 4 | 0 | 4 |
| other | 4 | 0 | 4 |
| | 91 | 0 | 91 |

Gillnet



Merwin trap

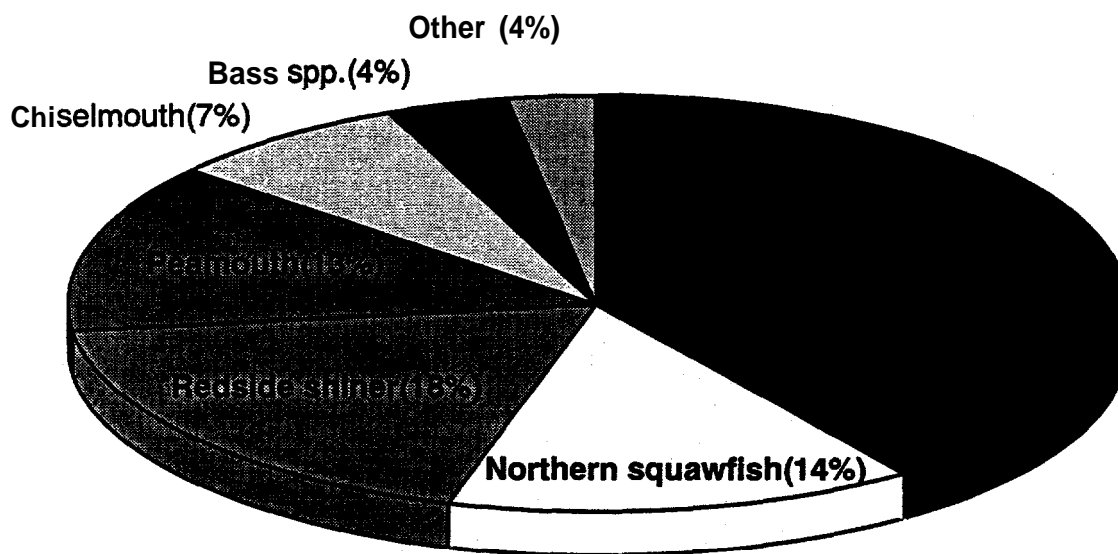


Figure 11. Percent of total catch of northern squawfish and incidentally caught species for gillnets and Merwin traps in 1994.

Salmonid By-Catch

A total of 294 **salmonids** (2% of total catch) were caught in both gill nets and **Merwin** traps combined in 1994 (Table 5). **Salmonids** composed 1% and 40% of the total catch in gill nets and **Merwin** traps, respectively (Table 5). The majority of the **salmonid** gill-net catch was adults (930A) and most (85%) were likely to survive at release (Table 6). **Merwin** traps captured a greater percentage of juvenile **salmonids** (98%) than adults (2%), all of which were released in good condition (Table 7).

An escape panel sewn **into** the spiller of the **Merwin** trap (**Figure 3**) allowed juvenile **salmonids** to escape the trap. In three trap sets wherein juvenile **salmonids** were caught and the escape panel was **open**, between 75% and 100% of the juveniles **observed** in the trap were able to escape through the panel. We feel that this was an important innovation to the **Merwin** trap and should be considered when using the trap in areas where there is a strong likelihood of catching juvenile **salmonids**.

RECOMMENDATIONS

1. **Continue developing the site-specific fishery to include additional locations where northern squawfish maybe concentrated to feed on juvenile salmonids, specifically below Bonneville Dam.**

ODFW biological evaluation crews working below Bonneville Dam in the spring have identified locations where northern **squawfish** catch rates have been relatively high. Incidental impacts to both salmon and sturgeon in these areas were no higher than in Bonneville Pool. It is likely that these areas would be productive sampling locations and the impacts to sensitive species would be as low as in other locations where the site-specific fishery has been implemented.

2. **As part of the site-specific fishery, use small-meshed gill nets exclusively to remove predator-sized northern squawfish. Also, test alternative gillnetting methods to increase effectiveness.**

Merwin traps were not effective in catching northern **squawfish** as part of this fishery. To maximize efficiency, only **gill** nets should be used in the site-specific fishery. Furthermore, alternative gillnetting methods should be tested to improve efficiency in catching predator-sized northern **squawfish**, specifically the use of gill nets of different dimensions (i.e., changes in length and width **only**; mesh size and line strength will not change) and the **drifting** of gill nets. There is no evidence to suggest that these kinds of changes might cause **an** increase in the incidental impacts to sensitive species.

Table 6. Gill-net **salmonid** catch and effort (net hr) by **location**, life stage, and condition at release in 1994. Condition codes: (1) minimal injury, certain to **survive**; (2) moderate injury, mayor may not survive; (3) dead, nearly **dead**, or certain to die.

| Location | Effort | Condition at release | | | | | |
|---------------------|----------------|---------------------------------|----------|----------------------|------------------------|-----------------------|----------------------|
| | | Juvenile salmonids ^a | | | Adult salmonids | | |
| | | 1 | 2 | 3 | 1 | 2 | 3 |
| Klickitat R. | 616.4 | 1 | 0 | 0 | 35 | 5 | 4 |
| Drano Lake | 399.1 | 7 | 0 | 1 | 49 | 3 | 2 |
| Wind R. | 81.6 | 0 | 0 | 1 | 19 | 1 | 0 |
| Richland | 66.5 | 0 | 0 | 0 | 4 | 0 | 3 |
| ClearWater R. | 53.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lower Granite | 49.3 | 0 | 0 | 0 | 1 | 0 | 0 |
| Umatilla R. | 27.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spring Creek | 23.4 | 0 | 0 | 0 | 3 | 0 | 0 |
| Miller Island | 17.5 | 0 | 0 | 0 | 2 | 0 | 0 |
| John Day R. | 15.8 | 0 | 0 | 0 | 1 | 0 | 0 |
| Lyons Ferry | 10.3 | 0 | 0 | 0 | 1 | 1 | 0 |
| Bingen | 7.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tucannon R. | 6.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 1,374.6 | 8 | 0 | 2^b | 115^c | 10^d | 9^e |

^a Not identified to species.

^b Juvenile salmonids were just-released hatchery smelts that got their teeth tangled in the net.

^c 72 chinook salmon, 37 steelhead, 2 chinook salmon (jack), 2 cutthroat trout, 1 sockeye salmon, 1 rainbow trout.

^d 2 chinook salmon, 7 steelhead, 1 cutthroat trout.

^e 5 chinook salmon, 4 steelhead.

Table 7. **Merwin** trap **salmonid** catch and effort (trap hr) by **location**, **life** stage, and condition at release in 1994. Condition codes: (1) minimal **injury**, certain to **survive**; (2) moderate injury, may or may not **survive**; (3) dead, nearly dead, or certain to **die**.

| Location | Effort | Condition at release | | | | | |
|-------------------------------------|-------------|------------------------------------|----------|----------|----------------------|----------|----------|
| | | Juvenile salmonids ^a | | | Adult salmonids | | |
| | | 1 | 2 | 3 | 1 | 2 | 3 |
| The Dalles Dam Cul-de-sac | 36.5 | 5 | 0 | 0 | 0 | 0 | 0 |
| Klickitat R. | 21.0 | 53 | 0 | 0 | 3 ^c | 0 | 0 |
| Drano Lake | 9.9 | 89 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 67.4 | 147^b | 0 | 0 | 3^c | 0 | 0 |

^a Not identified to species.

^b Approximately 155 juveniles exited the trap through an escape panel designed to minimize impacts due to handling. These fish were not considered "caught."

^c Steelhead.

3. Extend the sampling season so that crews are working during the time that northern squawfish are concentrated to feed on hatchery released fish (March 1- June 30).

Other criteria that dictate cessation of the fishery (i.e., those based on water temperature, salmon by-catch, and sockeye passage over Ice Harbor Dam, see Appendix A) are sufficient to limit incidental capture and impacts to sensitive species. A criterion based on date alone may unnecessarily limit northern squaw-fish catch following hatchery releases in June.

4. Extend the fishing period to an hour past sunrise.

Based on data from the 1994 site-specific fishery, catch rates of northern **squawfish** remain high through the sunrise time period, while the incidental catch rate of **salmonids** does not increase and may decline (**Figure 9**). To increase effectiveness in catching northern **squawfish**, fishing should be allowed during this time period.

5. Identify operational criteria that adequately protect sensitive species from harm and do not limit the potential to catch northern squawfish.

The sockeye salmon criterion that determines cessation within a **reach/reservoir** on the Columbia River should be changed **from** the passage of ten or more over a given dam to the catch of one or more in a given **reach/reservoir**. The sockeye criterion that determines cessation of **gillnetting** on the Snake River (i.e., passage of one sockeye at Ice Harbor Dam) should remain unchanged. The proposed criterion is almost as conservative in minimizing the potential impacts to sockeye and will greatly **simplify** data handling and logistics.

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APPENDIX A

Operational Criteria for the 1994 Site-Specific Fishery -

Terms Used in Criteria

Caught (incidental species): For gillnetting, any fish known to have been detained by the gear, including those that **free** themselves when the net is being checked. For Merwin trapping, any fish that is detained in and removed from the gear.

Salmonid: Only the genera *Oncorhynchus* and *Salvelinus*. **Excludes**, for example, the genus *Prosopium* spp., which can also be caught incidentally during sampling in the Columbia and Snake River **mainstems**. All incidentally caught juvenile **salmonids**, regardless of species or origin, **will** be considered equal when applying operational criteria.

Adult: Salmonids greater than approximately 51 cm (20 inches) in **length**, or as reported for dam passage.

Adult Equivalents: The number of adults represented by a larger number of juvenile **salmonids**, given an assumed survival rate to adulthood. Here we assume a general juvenile-to-adult survival rate of 0.02; hence, 50 juveniles = 1.0 adult equivalent.

Area: Generic spatial reference, may be synonymous with *location* or *site*.

Location: A moderate-sized reach of one shoreline and adjacent **mainstem** waters that extends approximately 3 km (2 **mi**) upstream and downstream **from** a landmark point (e.g., the mouth of a river into which smelts are released). One *location* **will** encompass several potential sampling *sites*.

Site: A relatively small reach (~ 400 m) within a *location* where sampling occurs.

A. Criteria Applicable to Both Gillnetting and Merwin Trapping

1. A general schedule of sampling times and a map of sampling locations will be provided to interested parties before these activities begin. A schedule and description of locations will be provided **to** interested parties before sampling is conducted in a given week.
2. All sampling will take place at night, beginning one hour **after** sundown and ending one hour before sunrise.

3. Sampling will not take place when water temperatures exceed **68°F**, as measured at the sampling site.
4. Sampling gears will not be operated within 500 feet of any fishway entrance.
5. All sampling will cease under the following conditions.

| Condition | Cessation Duration and Area |
|--|---|
| a. 1 adult sockeye passes Bonneville Dam | Cease for 1994 in Bonneville tailrace . |
| b. 1 adult sockeye passes Ice Harbor Dam | Cease for 1994 in Snake River. |
| c. ≥ 10 adult sockeye/day pass nearest downstream dam (relevant only to Columbia River) | Cease for 1994 in reservoir upstream of dam. |
| d. 1 adult sockeye caught ¹ | <u>Columbia:</u> Cease for 1994 in the reservoir where caught. <u>Snake:</u> Cease for 1994 in Snake River. |
| e. Cumulative incidental catch rate $\geq 3\%$ of adult chinook salmon or steelhead | Cease in all reaches until cumulative catch declines (with the passage of additional fish) to 2.5% for the adults of the species causing the cessation. |
| f. 31 May 1994 | Cease for 1994 in all reaches. |

B. Criteria Applicable to Gillnetting

1. Gill nets **will** be pulled from the water and inspected for incidental take of adult **salmonids** at least once **every** 45 minutes.
2. Gill-net fishing will cease under the following conditions.

¹ This criterion is a **fail-safe** for the unlikely event that the three other sockeye criteria (a-c) are not sufficient to prevent the catch of any sockeye.

| Condition | Cessation Duration and Area |
|--|-----------------------------------|
| a. ≥ 2 adult salmonids and/or adult equivalents of juvenile salmonids caught at 1 site, same night ² | Cease for night at that site. . |
| b. ≥ 5 adult salmonids and/or adult equivalents of juvenile salmonids caught in 1 location , same night | Cease for night in that location. |
| c. No. juv. salmonids (fair or dead) ≥ 0.5 . no. of northern squawfish (≥ 275 mm) caught at 1 site, same night. | Cease for night at that site. |

C. Criteria Applicable to **Merwin** Trapping

1. Adult and juvenile **salmonids** will not be held longer than 3 hours.
2. Adult **salmonids** and other incidental species will be released over the cork line with soft-meshed shallow dip nets or by other methods that maybe judged to be less **stressful** to the fish than **dipnetting**.³ We will develop and test whether escape panels (approximately 2" bar mesh) sewn into the spiller will allow juvenile salmonids to **volitionally** leave the traps.
3. **Merwin** trap operation will cease under the following conditions.

² Neither juvenile nor adult chinook salmon or steelhead are gilled in the small mesh sizes used. Most are entangled with their **mouth**, and some adults free themselves before being **lifted** out of the water.

³ **UW** researchers concluded that dip nets area more effective means of removing **salmonids** from **Merwin** traps than the other methods they tested: zipper, zippered escape holes, and a gated weir to exclude (large) adult **salmonids from** the spiller (Mathews et al. 1992).

| Condition | Cessation Duration and Area |
|---|--|
| a. No. adult salmonids > no. northern squawfish (≥ 275 mm) in any 3-h period at 1 site ⁴ | Cease for night at that site. . |
| b. Adult salmonid catch rate ≥ 5 /trap. h at 1 site | Cease for night at that site. |
| c. ≥ 25 juvenile salmonids per northern squawfish (≥ 275 mm) at 1 site | Cease for night at that site. |
| d. Density of fish held in trap (when adult salmonids caught) > 1.0 lb/cu. ft ⁵ | Do not cease. Shorten period for checking and emptying trap by 1 h until criterion is met. |

⁴The corresponding criterion in 1993 did not **specify adult/juvenile salmonids** or size of northern squawfish. Because we will count only predator-sized northern **squawfish**, the proposed criterion is much more conservative than that for 1993.

⁵This poundage criterion applies to a water temperature of **50°F**. For each degree of water temperature below or above **50°F**, the poundage will be increased or decreased 5%/0 respectively.

REPORT E

Handling and Transportation of Northern Squawfish Harvested under the Columbia River Northern Squawfish Management Program in 1994 and Evaluation of the Cost Effectiveness of a Food-Grade Fish Handling Network

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Milwaukee, Oregon

1994 Annual Report

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ABSTRACT

Three fisheries for harvesting northern **squawfish** (*Ptychocheilus oregonensis*) were implemented under the Columbia River Northern **Squawfish** Management Program during the spring and summer of 1994. Approximately 164,000 northern **squawfish** were harvested. Most harvested fish must be handled and transported from points of harvest to points of appropriate end-use or disposal to comply with state laws and social ethics prohibiting wanton waste of this resource.

We describe the fish handling and transportation system that we implemented in 1994. This system required cooperation and coordination of activities among private-sector end users of harvested northern **squawfish** and managers who were responsible for fishery implementation. The 1994 system included a food-grade fish collection **network**, established in a section of the lower Columbia River, that packaged and sold frozen northern squawfish to Stoner Fisheries, Inc. in Spirit Lake, Iowa. Fish harvested in other program areas were rendered. We conducted a cost comparison of the food-grade fish handling option with an alternative rendering-only option.

Actual cost of the 1994 food-grade fish handling network was compared to the cost for implementing a rendering-only network in the same area. Costs were based on **handling** of 111,536 pounds of northern **squawfish harvested** in the food-grade network area. Sale of **food-**

grade fish to Stoner Fisheries, Inc. **generated** \$8,677 **from 78,881** pounds **of useable** fish. Stoner also paid \$3,642 in transportation charges that otherwise would have been borne by the program as rendering pick-up charges. Implementation of the food-grade network cost \$38,927, which was \$4,241 less than the cost for a rendering-only fish handling network.

The total spent for implementing the entire fish handling system in 1994 was \$156,881. With cost recovery from sale of northern **squawfish** to Stoner Fisheries, Inc., the net cost for the fish handling system was \$148,204.

The cost analysis among fish handling options indicated that a food-grade northern **squawfish** handling network in the lower Columbia River (from below The **Dalles** Dam to Vancouver, Washington), in combination with rendering of northern **squawfish** harvested elsewhere, was the most cost-effective mix of food-grade and rendering handling options for the Northern Squawfish Management Program. **Aside** from program **cost** considerations, this option preserves the highest value end-use of harvested northern **squawfish**.

INTRODUCTION

This report provides a description and cost summary of the 1994 northern **squawfish** handling system. This system included a food-grade collection network that packaged and sold frozen northern **squawfish** to Stoner Fisheries, **Inc.** in Spirit Lake, Iowa. A cost comparison of alternative handling options is provided. Field logistics, food-grade processing information and other end-uses are also discussed.

PROJECT DESCRIPTION

Fish **Handling** Options Available to the Program

In 1994, we examined the cost-effectiveness of two alternative options for handling **northern** squawfish harvested under the Columbia River Northern Squawfish Management Program. These options included rendering all the northern **squawfish harvested** by the program or selling some of the carcasses to Stoner Fisheries, Inc. and rendering the remaining volume. Rendering involves grinding **whole** fish and using the resulting product as an animal **feed** additive, fertilizer, etc., and is the lowest value end-use available to the program. The products of rendering are animal feed supplements and oil. Renderers do not pay for the carcasses. Rather, they charge a pick-up and disposal **fee** that is assumed by the handling project. Stoner Fisheries purchases food-grade “rough” **fish**, minces the **flesh**, and **sells** the product to processors of frozen fish products.

In September 1994, we provided to the program a cost comparison between these handling options and we demonstrated that a combination of food-grade handling and rendering is the least-cost fish handling option. Food-grade northern **squawfish** provides a cash return to the **program**, but more handling is required to maintain **quality**. Rendering requires less fish handling, but the project must pay for pick-up and disposal of the carcasses. Our assessment of handling options focused on whether the revenue generated **from** the sale of food-grade fish offsets the added cost for the additional fish handling required to maintain food-grade quality.

Fish Handling Requirements Common to Both Options

Both fish handling options require some basic services, facilities and equipment. Following is a review of the minimum handling requirements.

1. The carcasses must be removed from the field daily and stored in a secure cooler. Leaving barrels of carcasses outside overnight is unacceptable for sanitary and security reasons. Only very small quantities can be frozen in chest **freezers** and removed later. Large quantities must be collected and transported to storage centers on a daily basis.
2. The renderer in Portland requires carcasses in at least fair condition because the **facility** is located within the city limits and odor complaints are **frequent**. Consequently, large quantities of northern **squawfish** that are ultimately rendered in Portland must be handled with ice.
3. Labor is required to transport carcasses to central receiving locations and to assist with disposal or shipping to other destinations.
4. Central storage locations must have at least a walk-in cooler and cleaning facilities.

Description of the 1994 Food-Grade Fish Handling Network

In 1994, we implemented a limited food-grade collection network centered near **Warrendale**, Oregon. Larry Stoner of Stoner Fisheries, Inc. in Spirit Lake, **Iowa**, bought whole, frozen northern squawfish for \$0.11 per pound and paid \$0.04 per pound for transportation from the collection center in Oregon to his **plant** in Iowa. Food-grade fish were collected from **Gleason, Washougal**, The Fishery, Hamilton Island, **Bingen**, The **Dalles** and **Giles** French **sport-reward fishery** registration sites and from Bonneville and The **Dalles** dams (**Figure 1**).

The food-grade collection area was quite productive in terms of northern **squawfish** harvested. Although it represented only about **20%** of the total program **area**, it produced 58% of the **programwide** harvest. The food-grade handling area was logistically favorable because most travel was along relatively short distances byway of Interstate 84. These two features **combined** to minimize fish handling and transportation costs.

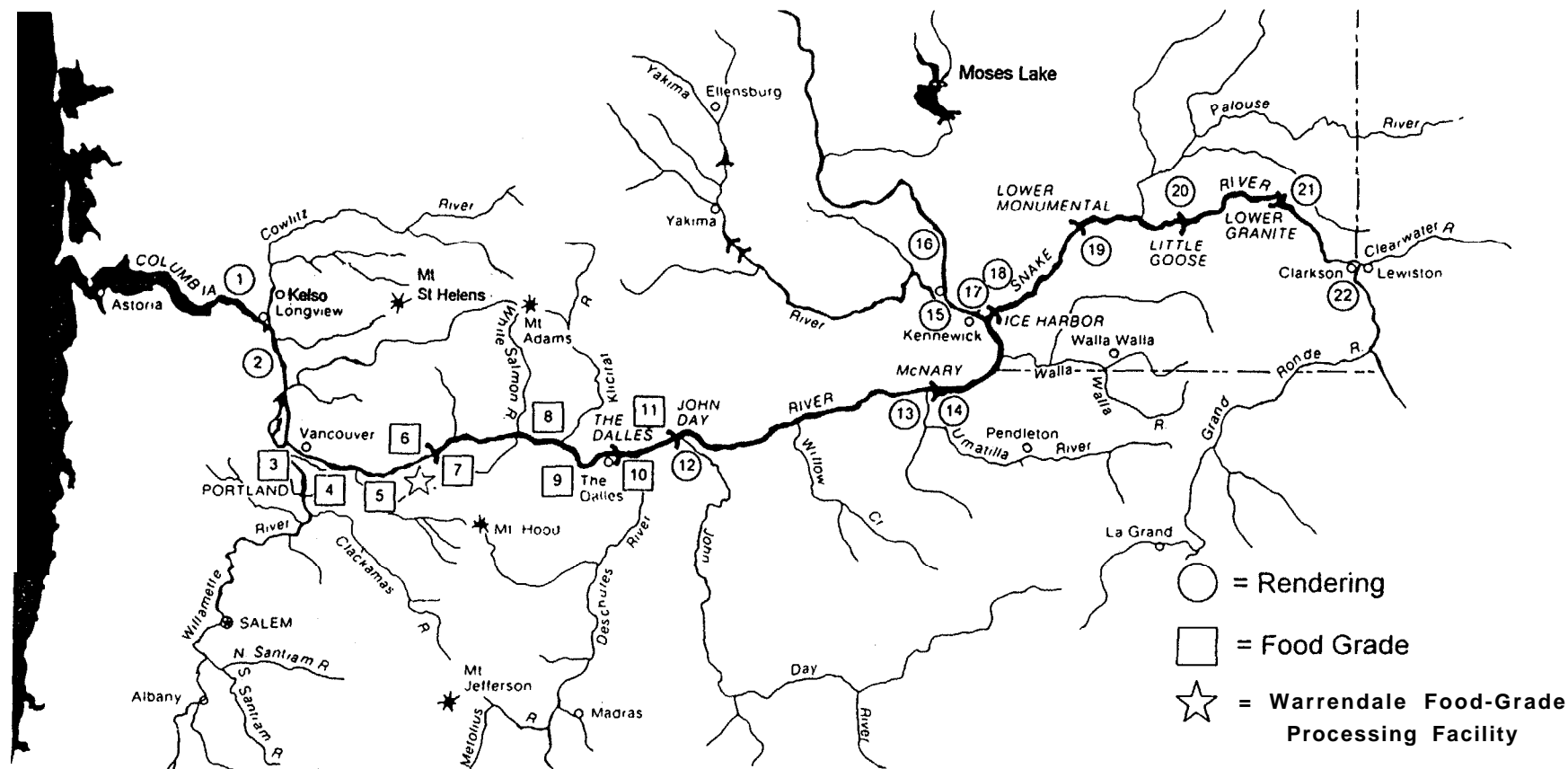
The fish handling network employed a driver who collected the iced northern squawfish from drop-off locations (Portland, **Oregon**; Bonneville **Dam**; The **Dalles** Dam; and **Dallesport**, Washington located across the Columbia River from The **Dalles**, Oregon) and delivered them to the Warrendale, **Oregon**, facility where they were packaged and frozen (**Figure 1**). This system greatly reduced the transportation responsibilities of **dam-angling** and sport-reward fishery technicians. Additional costs for food-grade packaging were minimized because the labor already in place for transporting fish was also used for packaging the fish. Further cost savings were realized because the **dam-angling** and sport-reward technicians did not need to clean coolers at the end of each day. This task was accomplished quickly with a steam cleaner at the Warrendale facility. **Dam-angling** and sport-reward technicians are now experienced fish handlers and provided very high yields of food-grade **squawfish**. Eighty-three percent (93,059 pounds) of the northern **squawfish** harvested from the food-grade area (112,700 pounds) were shipped to Stoner for processing.

Description of Rendering-Only Fish Handling Areas

The rendering-only locations included **Kelso, Pasco** (located across the Columbia River from Kennewick), and **Clarkston**, Washington (**Figure 1**). The rendering-only locations were facilities that provided walk-in coolers, disposal barrels and cleaning equipment. Sport-reward fishery technicians and dam anglers delivered northern squawfish carcasses to these locations, deposited them into barrels, and cleaned their coolers. The facility manager would provide assistance as needed to drivers who came to pick up fish to be rendered. Rendering-only northern squawfish harvest locations handled about 45,000 pounds of northern squawfish during the 1994 season.

Efforts were made in previous years to collect food-grade northern squawfish from the areas that are now rendering-only areas. However, relatively small numbers of fish harvested, difficult handling logistics, and the high cost of ice needed to preserve food-grade fish quality preclude cost-effective food-grade handling in these areas.

Due to cost restraints and transportation difficulties, no effort was made in 1994 to collect northern **squawfish** from the site-specific gill-net fishery or from **McNary** Dam.



Sport-Reward Sites

- | | | | |
|---------------|---------------------|---------------------|----------------|
| ① Cathlamet | • 5 The Fishery | • 11 Giles French | ① 17 Hood Park |
| ② Kalama | • 6 Hamilton Island | ② 13 Umatilla | ② 22 Greenbelt |
| • 3 Gleason | ⑧ Bingen | ③ 15 Columbia Point | |
| • 4 Washougal | • 9 The Dalles | ④ 16 Vernita | |

Darns

- | | |
|---------------------|------------------------|
| ① Bonneville Dam | ⑧ Ice Harbor Dam |
| • 10 The Dalles Dam | ⑨ Lower Monumental Dam |
| ③ John Day Dam | ⑩ Little Goose Dam |
| ④ McNary Dam | ⑪ Lower Granite Dam |

Figure 1. Map of Northern Squawfish collection and processing network.

METHODS

We compared the actual cost of the 1994 food-grade fish handling network with the cost that we would have had for rendering **all** the carcasses obtained from the food-grade collection area. The comparison is based on 111,536 pounds of northern **squawfish** handled in the **food-grade** collection area in 1994. The rendering-option cost information is based on the minimum needs of a process that would provide carcasses to the rendering facility in Portland, **Oregon**, in satisfactory condition so that they would be **free** from potential sanitation or negative public perception problems. The requirements for implementing each option are listed in Table 1 along with cost-recovery information.

Explanation of Fish Handling Requirements

This section explains the fish handling requirements listed in Table 1 and compares the differences, if any, between food-grade and rendering-only **handling** requirements.

Facility rental pays for the use of central storage facilities where harvested squawfish are collected and packaged for food-grade use or held until a renderer picks them up. These costs include space rental, use of fork **lifts**, scales, cleaning **equipment**, water and utilities. Facility rental costs are **common** to both fish handling options.

While a walk-in cooler can be used to hold fish for rendering a freezer is needed to preserve food-grade northern squawfish. The cost of renting **freezer** space was \$300 per month more than the cost of renting cooler space. Likewise, less ice is necessary to maintain fish for rendering, and this cost difference was \$567 per month in 1994.

On average, processing and packaging of food-grade fish required about 2.5 hours of additional labor each day beyond that required for a rendering only program. The monthly cost difference for the additional labor was \$1,076.

Vehicle rental costs include rent, mileage and **fuel** for vehicles that transport the northern squawfish carcasses. These costs are the same among both handling options.

Only food-grade northern squawfish require packaging. The cost of packaging (i.e., waxed boxes and plastic liners) for the 1994 season was \$1,329.

The food-grade project area did produce some low-quality northern **squawfish** that required rendering. The total cost for rendering the 18,477 pounds of low-quality northern squawfish in the food-grade area was \$865 during the 1994 season. Rendering charges for the volume of fish handled in the food-grade collection area would have been \$6,110 if **food-grade** fish had been rendered.

Table 1. 1994 northern **squawfish** food-grade collection network cost **summary** and **rendering-only** cost comparison in the food-grade collection area(**Gleason, Washougal, The Fishery, Hamilton Island, The Dalles and Giles** French sport reward **sites**; Bonneville and The **Dalles** dams).

| RENDERING ONLY COSTS (projected) | | | FOOD-GRADE NETWORK COSTS (actual) | | |
|---|--------------------------------|-----------------|-----------------------------------|-----------------------------------|----------------|
| Requirements | cost | 4.5 Mo. | Requirements | cost | 4.5 Mo. |
| Facility Rent | \$800/mo | \$3,600 | Facility Rent | \$800/mo | \$3,600 |
| cooler | \$700/mo | \$3,150 | Freezer | \$1,000/mo | \$4,500 |
| Ice | \$1,100/mo | \$4,950 | Ice | \$1,667/mo | \$7,505 |
| Labor | \$14.50/hr 8 hrs/day | \$16,820 | Labor | \$14.50/hr 10.5 hrs/day | \$21,664 |
| Vehicles | \$1,897/mo | \$8,538 | Vehicles | \$1,897/mo | \$8,538 |
| Packaging | \$0 | \$0 | Packaging | \$1.00/box | \$1,329 |
| Rendering | 111,536 lb | | Rendering | 18,477 lb | |
| Pick-up | \$800/mo | \$3,600 | Pick-up | \$100/mo | \$450 |
| Volume fee | \$45/ton | \$2,510 | Volume fee | \$45/ton | \$415 |
| | | | Crayfish Bait | 1,200/lb | \$0 |
| Subtotal | | \$43,168 | Subtotal | | \$48,001 |
| Cost Recovery | | \$0 | cost Recovery | | |
| | | | 93,059 lbs Shipped | | |
| | | | 78,881 lbs. processed* | | |
| | | | @ \$0.11/lb | | \$8,677 |
| | | | Stoner shipping refund | | \$397 |
| Total Cost | | \$43,168 | Total Cost (after sale) | | \$38,927 |
| Food-Grade cost savings compared with rendering | | | | | \$4,241 |

* **Stoller** rendered 14,178 pounds due to small size, freight damage or other quality reasons.

RESULTS AND DISCUSSION

Cost Recovery through Sale of Food-Grade Fish

Sale of food-grade northern **squawfish** to Stoner Fisheries, Inc. generated \$8,677 in direct revenues (from 78,881 pounds of **minceable** northern **squawfish**). Stoner also paid \$3,642 in transportation charges that otherwise would have been borne by the program as rendering pick-up charges. Table 2 summarizes Stoner's processing figures and payment totals for the 1994 season. Stoner received three shipments of northern **squawfish** from the program during 1994. Table 3 provides information concerning processing dates, food-grade yields and revenues generated from each shipment.

Results of Cost Comparison among Fish Handling Options

Table 1 presents the results of the comparison between the actual cost of the 1994 **food-grade** handling network and the projected cost of a rendering-only network. The food-grade **network**, including cost recovery (\$3 8,927), was \$4,241 less expensive than an alternative rendering-only network. The costs for a rendering-only network in the food-grade collection area during the 1994 season would have been \$43,168.

1994 Overall **Fish** Handling System Cost Summary

The cost associated with the entire 1994 northern **squawfish** handling system is summarized in Table 4. The cost to operate the 1994 food-grade network (not **including** cost recovery from fish sales to Stoner Fisheries, Inc.) was \$48,001. Total cost for the rendering-only areas (**Kelso, Pasco, and Clarkston**) during the 1994 season was \$12,086. The **projectwide direct** handling cost for both the food-grade collection area and rendering-only locations was, therefore, \$60,087. One-time charges of \$2,600 were incurred for moving, storing and distributing equipment during the 1994 season.

The fixed cost for managing the project and for coordinating among participants was \$94,194. Therefore, the total spent for the project was \$156,881. **With** cost recovery (i.e., fish sales to Stoner Fisheries, Inc.), the net project cost was \$148,204.

Other End Uses for Northern **Squawfish** Harvested in 1994

Scott Lewis from Oregon State University was given 1,164 pounds of low quality northern **squawfish** from the food-grade fish handling area for use as bait to facilitate his crayfish research.

Table 2. **Summary** of Stoner Fisheries, Inc. processing and payment information during 1994.

| | |
|---|-----------------------------|
| Total Fish Shipped: | 93,059 pounds |
| Total Fish Processed: | 78,881 pounds |
| % Processed | 85%^a |
| Total Reimbursement (78,881 pounds @ \$0.1 l/pound) | \$8,677^b |
| Shipping paid by Stoner (91,050 pounds@ \$0.04/pound) | \$3,642 ^c |
| Total sales value including shipping costs | \$12,319^d |

•Fifteen percent of the northern **squawfish** received by Stoner were not food-grade quality due to small size, shipping damage or poor quality.

^b Stoner paid cash for usable northern squawfish only (78,881 pounds).

^c Stoner paid for shipping from Oregon to Iowa (except for 2,009 pounds). This **is in** lieu of alternative handling costs which the program would have had to pay.

^d This total represents the total value of Stoner's contribution to the program (cash payment and shipping costs).

Table 3. Summary of processing and payments by shipment of northern squawfish to Stoner Fisheries, Inc. during 1994.

Shipment #1. Processed June 21, 1994:

Total Fish received: 37,805 pounds

| | |
|------------------------------------|---------------|
| Fish too small or of low quality:, | 4,280 pounds |
| Net processed fish: | 33,525 pounds |
| o/o processed (food-grade); | 88.7% |

Total Production of Minced fish 11,160 pounds

| | |
|----------------------|-------|
| Yield - All fish: | 29.5% |
| Yield - Usable fish: | 33.3% |

| | |
|------------------------------------|------------|
| Amount received (@ \$0.1 1/pound): | \$3,687.75 |
|------------------------------------|------------|

Shipment #2. Processed August 1, 1994

Total Fish received: 43,330 pounds

| | |
|-----------------------------------|---------------|
| Fish too small or of low quality: | 7,889 pounds |
| Net processed fish: | 35,441 pounds |
| % processed (food-grade); | 81.8% |

Total Production of Minced fish: 13,453 pounds

| | |
|-----------------------------|-------|
| Yield - All fish: | 31.1% |
| Yield - Usable fish: | 38.0% |

| | |
|------------------------------------|------------|
| Amount received (@ \$0.1 1/pound): | \$3,898.51 |
|------------------------------------|------------|

Shipment #3. Processed November 9, 1994.

Total Fish received: 11,924 pounds

| | |
|-----------------------------------|--------------|
| Fish too small or of low quality: | 2,009 pounds |
| Net processed fish: | 9,915 pounds |
| % processed (food-grade); | 83.1% |

Total Production of Minced fish: 3,321 pounds

| | |
|--------------------------|-------|
| Yield - All fish: | 31.1% |
| Yield - Usable fish: | 33.5% |

| | |
|------------------------------------|------------|
| Amount received (@ \$0.1 1/pound): | \$1,090.65 |
|------------------------------------|------------|

Table 4. Summary of the total cost for the 1994 **northern squawfish** handling network.

| Program component | Total cost |
|--|----------------|
| Food-Grade Collection | \$48,001 |
| Rendering-only Collection | \$12,086 |
| Equipment Handling and Storage | \$2,600 |
| Fixed Costs (Administration , contracts, negotiations, coordination and field supervision) | \$94,194 |
| Total | \$156,881 |
| Cost Recovery (Stoner sales) \$8,677 | |
| Total, after Cost Recovery | \$148,204 |

CONCLUSIONS AND RECOMMENDATIONS

The cost analysis among fish handling options that we completed in 1994 indicated that a food-grade northern **squawfish** handling network in the lower Columbia River (**from** below The **Dalles** Dam to Vancouver, Washington) in combination with rendering of northern squawfish harvested elsewhere was the most cost-effective mix of food-grade and rendering handling options for the Northern Squawfish Management Program. **Aside** from program cost considerations, this option preserves the highest value end-use of harvested northern squawfish.

Our recommendation is for a continuation of a food-grade fish handling **network**, which should be implemented through cooperative efforts among private-sector concerns and which should be patterned **after** the 1994 food-grade fish handling network.

